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FIRST STEPS

IN

GENERAL KNOWLEDGE.

PART I.
THE STARRY HEAVENS.

PUBLISHED UNDER THE DIRECTION OF
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FIRST STEPS IN GENERAL KNOWLEDGE.

PART FIRST.

The Starry Heavens.

CONVERSATION I.

THE FIXED STARS.

One fine summer's night, long after sunset, and when the sky began to glitter with stars, a gentleman and a little boy were seen walking along the high road which led to a beautiful village in Wiltshire, where they lived. There was a shorter and pleasanter way to their home across the fields, but the dew was heavy on the grass, and they found it best to keep the road. The little boy was about seven years old: he was in high spirits, for he had been spending the evening with a very kind aunt, who had taken pains to entertain him, and had

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"Not with any certainty. It would be useless to tell you of the billions and trillions of miles which the nearest are supposed to be from the earth. Such words would not help you to understand the real distance, which, after all, is a thing only known to God. 'Is not God in the height of the heavens? and behold the stars how high they are!' (Job xxii. 12.) The starry heavens are, indeed, full of wonders; and it is not surprising that they excited the devout attention of the Psalmist David, leading him to exclaim, 'When I consider thy heavens, the work of thy fingers, the moon and the stars, which thou hast ordained; What is man, that thou art mindful of him? and the son of man, that thou visitest him?' (Ps. viii. 3, 4.)"

"I wonder, papa, whether David saw these very same stars we are looking at. Do they stay in the same places year after year, or do they move about and go away?"

"Nearly all the stars you can see this evening are called *fixed* stars, because they remain at the same distances from each other, and occupy, apparently, the same places in the heavens which they did hundreds of years ago. But a very close observation of some of them has shown that they have a certain degree of motion, though too small to make any sensible difference in their position. Some of the stars noticed by early astronomers have, however, quite disappeared; while others have come into sight for a time, and then gradually vanished."

"How I should like to know where they are gone to, and why they went away, and whether they will ever come back again, and what they are made of, and a great many other things about them!"

"You must be contented to remain in ignorance of many things; but you will be surprised to learn one thing, which astronomers say of these thousands and millions of stars, these little bright spots that spangle the skies."

"And what do they say, papa?"

"That they are all of them *suns*, just like our own sun, but at such an immense distance as to look like specks of light."

"What a strange idea! Why should there be such a number of suns, and at such a distance, too, that they scarcely give us any light?"

"You must not fancy that all those beautiful stars were made for the use of this earth. If they are suns, they probably give light to worlds like ours, which are placed near to them, and are hidden from our sight."

"And do you really think, papa, that there are hundreds, and thousands, and millions of worlds like ours, lighted up by all those suns?"

"We have every reason to believe so, nor can we suppose that all those worlds are empty and without inhabitants. Perhaps the people in them look upon our sun just as we do on theirs, and have no other idea of its appearance or use than as one of the fixed stars."

"Not a *fixed* star, surely, papa, when it rises and sets every day?"

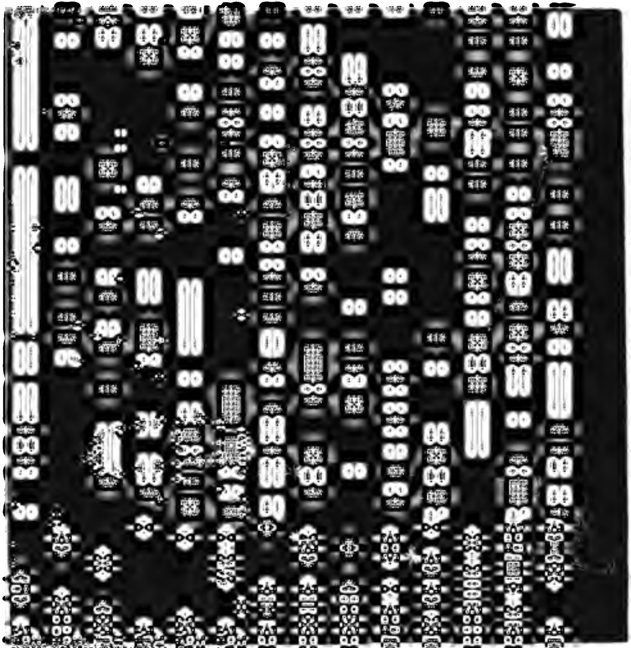
"It appears to do so, to us; but I will explain to you, another day, the reason why it seems to move, while it is really a fixed star, like those you see in the sky, many of which also appear to rise and set. But if you look towards the north, I will help you to find out several stars which never set, or become invisible to us in this country."

"Which is the north?"

"Turn your back to the spot where the sun set this evening, and your left hand will then be towards the north."

"I am looking to the north, papa, but I do not think I shall ever be able to know one star from another, or to find out, among so many, the particular stars which you wish me to look at."

"It is puzzling, I know, but in order to help the finding of the fixed stars, the ancients arranged them into groups, called *constellations.* These constellations are named after different persons, animals, and things, and in the course of time I hope you will be able to find out many of them. One of the most striking constellations is in the form of a cross. It cannot be seen in this country, but it is described as being very beautiful. Among those which we can see at present, I shall be contented if I can make you acquainted with two. That which I am now going to show you, is called the Great Bear. There are seven principal stars in it, and most people soon learn to distinguish them, for they are bright and beautiful stars. Look to the north, in the direction I am pointing, at seven large stars, and of these you will see that there are four in the body of the bear, and three forming the tail.—There are other stars in this constellation: but, from the seven conspicuous stars, country people call it Charles's *Wain,* or



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waggon; the four stars being in the place of the wheels, and the three stars serving for the team. Others fancy it like a plough. Do you see it?"

"I think I do. I see seven stars in the shape you speak of, but some of them are much brighter than others, and there are a great many little stars mixed with them and round about them."

"Quite right. But you see the seven stars distinctly, and that is enough. Take particular notice of the two foremost stars in the body of the Bear; or, if you choose to fancy it a waggon, take particular notice of the two hind wheels, for those will help you to find another constellation, called the Little Bear, which is very much like this, but smaller, and in a different position. When we get home I will show you a figure of the large stars in each constellation, with the bears, which you know are only imaginary. Two of the stars in the Great Bear are nearly in a line with the last star in the tail of the Little Bear. See if you can find it so in the sky."

"——I have found it out, at last. Here is the Great Bear, and there is the Little Bear. I am very glad I know two of the constellations. Will you show me some more, papa?"

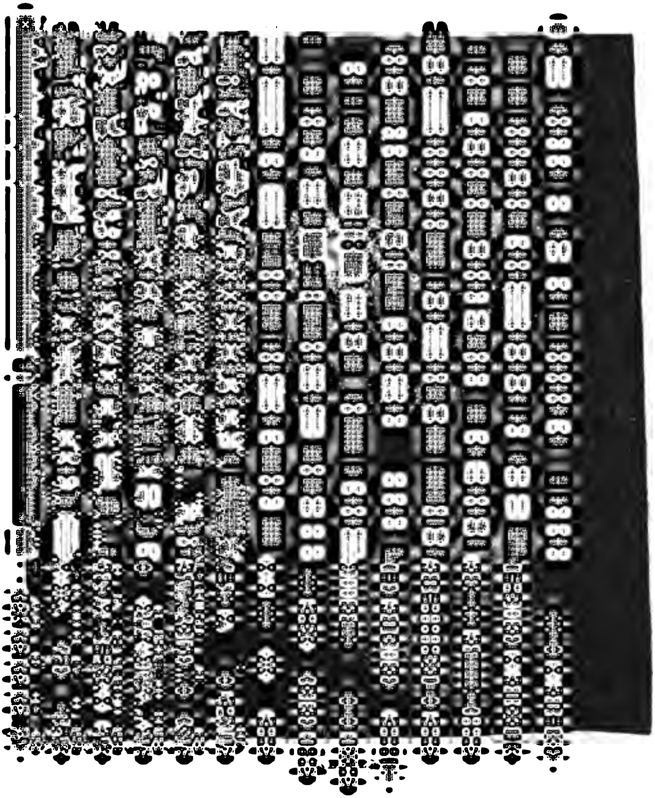
"Not this evening. Look again at the Little Bear, especially at the last star in the tail; for that is an important one. It is very near to a point in the heavens called the North Pole, and the star is therefore known as the Pole-star. You will be glad to look at that star again another time, when we shall have more to say about it; therefore do not forget its place in the heavens; nor the two stars which are pointers to it."

"I am surprised that the Pole-star is thought so much of. It is not so large or beautiful as some of the others, and I should not have guessed that there was anything particular about it."

"Talking of the size of the stars, I must tell you, that the largest and brightest stars are called stars of the first *magnitude* or *size;* the next, stars of the second *magnitude;* and so on up to the sixth or seventh.

"Now turn this way, and look at a faint whitish cloud or streak across the sky. This is called the Milky Way, and you will be very much astonished to learn what it really is."

"Why, what can it be, papa, but a thin cloud? I can see the stars through it."



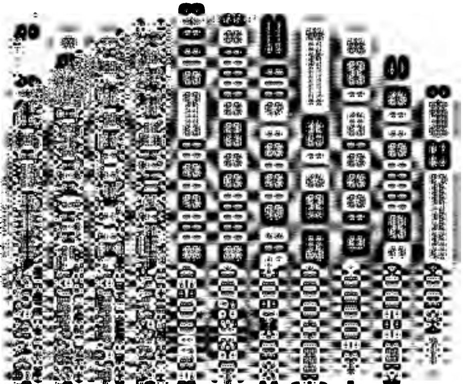
"That thin cloud, as it seems to be, is, in fact, the confused light of millions and millions of stars, too small to be seen by the eye, although their vast numbers cause the faint light you see."

"How very wonderful! Can these stars be seen through a telescope?"

"Very distinctly. In one small part of the Milky Way two hundred and fifty thousand stars have been counted; and, besides this Milky Way, there are dim and cloudy spots in the heavens, which are also found to consist of clusters of distant stars. These, from their *misty* appearance, are called *nebulæ,* the Latin word *nebula* signifying a *mist* or *cloud.*"

"Why, papa, there seems no end to the number of the stars. And if they are all suns, and have worlds belonging to them, and if the worlds are full of people, like our own world, what crowds and crowds of people there must be living now!"

"It is, indeed, my boy, a wonderful subject, and one that is quite beyond our comprehension. And think what that Divine Power must be which created all these things, and which upholds them every moment. Bring me your Bible when we get home, and I will show you one out of the many [illegible] and [illegible] ness [illegible] to [illegible] r."



CONVERSATION II.

THE SUN.

LITTLE Henry was an inquisitive boy, as well as a talkative one, and his curiosity was strongly awakened by what his papa had told him about the stars. The next morning, as soon as he was up, he repeated what he had heard to his brother Robert and his sister Mary, who were both younger than himself. The little folks agreed together, that after breakfast they would ask papa to tell them something more about the stars. But papa went into his study earlier than usual, and they were obliged to wait till the middle of the day. He no sooner came out at luncheon time, however, than they all gathered round him, begging him to go on talking as he did to Henry last night, and to show them the pictures of the Great and Little Bear.

Their papa kindly complied, and also repeated what he had said to Henry about the fixed stars, and about our sun being fixed, although it appears to our eyes to rise and set. He added, " I hope you will soon be able to understand how this is.

Do you remember, Mary, what it was that amused and surprised you so much the first time you rode in a carriage?"

"Oh yes, papa; the trees and the houses, and the road itself, all looked as if they were moving very fast. They seemed to run backwards much faster than we moved forwards, and yet, of course, they were standing still all the while."

"Of course they were. And this curious appearance will teach you that we must not always believe our own eyes. In the same way we seem to see the sun rise and set, and we talk of his rising and setting; but, in reality, it is our earth that is moving while the sun stands still."

"But *can* it move without our knowing it?" said little Robert. "Perhaps it creeps along very slowly indeed, and that is why we do not find it out. Or perhaps it moves in the night, when we are all asleep?"

"It neither moves slowly, nor by night only, but it keeps on moving very fast, night and day, without making the least noise; and the reason we do not feel it move is, that we all move with it, and so does the air or atmosphere we breathe. Here is a picture, showing the sun fixed in the centre, [illegible] of [illegible] me [illegible] the [illegible] her [illegible]

[illegible] NETS.

[illegible] und [illegible] does [illegible]

[illegible] our [illegible] very [illegible] first [illegible] globe [illegible] thousand

[illegible]

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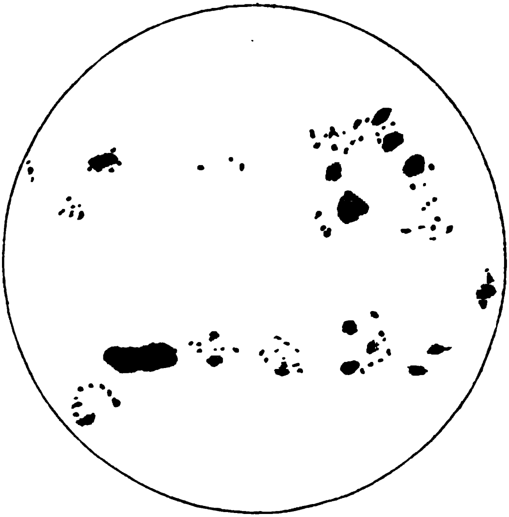
or shaded spots were seen on his bright face; these spots were found to traverse the breadth of the sun in fourteen days, and then, after being lost to the sight for a time, they always appeared again on the other side and travelled across it as before. This orange which I hold in my hand has a dark spot on one side, and, as I turn it round and round,



SPOTS ON THE SUN.

you sometimes see the spot, and sometimes lose sight of it. The spots on the sun move in the same manner, along with the globe itself."

"It must hurt people's eyes very much to look at the sun through a telescope," said Henry. "It made my eyes ache when I looked at it through a piece of smoked glass."

His father explained, that, to prevent any mischief to the eyes, coloured glasses are placed in the telescope to soften the light.

"Does any one know what the sun is made of, or why it is so very bright?" said Mary.

"No one can fully explain the nature of the sun, or of the light and heat which he sends forth. We know that it was God who 'made two great lights, the greater light to rule the day, and the lesser light to rule the night; He made the stars also.' (Gen. i. 16.) Thus David says, 'The day is thine, the night also is thine: thou hast prepared the light and the sun.' (Ps. lxxiv. 16.) And we know, that in his mercy, he causes this glorious sun 'to rise on the evil and on the good,' (Matt. v. 45,) and by its warmth and light makes the earth fruitful and delightful, and preserves us all in life. There are also many wonderful things to be learned about light and heat, which you will hear of at some future day; but, after all, our knowledge is small, and we must be content, like children, to receive many blessings from the hand of our heavenly Father, without fully understanding their nature or value."

"And does the sun light up and warm the rest of the worlds marked in the picture?" Henry asked. "If he does, some of them must be hotter than our world, and some colder, for one or two are very near to him, and others very far off."

"You are right. There are eight principal worlds, or *planets,* as they are called, two of which are nearer to the sun than we are, and five farther off. These, with several smaller planets moving near each other, make up what is called the *Solar System.*"

Henry wished to know why these worlds are called planets.

"The word *planet,*" said his father, "means a *wanderer*, and is the name given to those bodies which are always moving in circles in the heavens. The paths of the planets are not, however, perfect circles, but rather incline to the oval shape. Now, look again at the two pictures of the Solar System, and tell me the names of all the planets, beginning with that one which is nearest to the sun."

"The nearest is Mercury,—then Venus,—then the Earth; but is that a planet?"

"Yes: for it is a wanderer like the rest."

"Next to the Earth is Mars, then four planets whose paths cross each other,—then Jupiter,—then Saturn,—then Uranus,—and last, Neptune."

"Where you see the paths of four little planets crossing each other, there are now known to be at least eight, but it is impossible to represent them in so small a space."

"I am afraid I shall soon forget the names of the planets," said Henry, "there are so many of them. For besides those that have names set against them, there are several little ones near to Jupiter, Saturn, and Uranus."

"Those are not principal planets, but moons, or secondary planets, to light those distant bodies on their way. Our earth has only one moon, but Jupiter has four, Saturn has seven, and Uranus six moons.

Diameter of the Sun	882,000 miles.
Revolution on its Axis	25 days, 10 hours.

CONVERSATION III.

THE PLANET MERCURY.

The same evening, Henry and Mary and Robert reminded their papa that he had promised to talk about each of the planets, and he began thus: "We are now going to talk about Mercury, that near neighbour of the sun, whose path through the heavens is so bright and glowing, that the planet is nearly lost sight of in the sun's rays."

"Can Mercury ever be seen, papa?" said Mary. "Have you ever seen it?"

"Mercury can be seen, and I have seen him. But he is a planet that can only be viewed in clear weather, just before sunrise, or just after sunset. He is a small planet, with a bright white light."

"Do planets shine like stars?" said Henry. "I had fancied them worlds like ours, and that it was only the sun and the fixed stars that gave light."

"You are quite right in supposing that only the sun and the fixed stars give out light. The brightness of the planets is not their own, but is all gained from the sun. The sun shines upon them, and we see them in *his* light, not in any light of their own. Yet even this borrowed light is enough to make them very brilliant objects. Yonder is Jupiter, and I am sure you will think him a beautiful planet."

"Do you mean that large star, papa? I was going to show it you, and tell you that I had found a star of the first magnitude."

"Yes, that is Jupiter, and I hope you will soon become so well acquainted with him as not to mistake him for a fixed star."

"And will you, some day or other, show me Mercury?" asked little Robert. "I wish very much to see the sun's 'near neighbour.'"

"I will endeavour to gratify you with a sight of him ere long. This planet, like our earth, has two movements; one round the sun, the other on his own *axis*, as it is called. A carriage wheel, you know, has two motions; it not only moves along the road, but turns round very fast upon a pole to which it is fastened. This pole is called the *axle* or *axis*, and when we speak of a planet or other globe moving on its own axis, we mean that it has the same kind of motion as if it were turning upon a pole or axis."

"I know another thing besides a carriage wheel," said Henry, "that has two movements—my spinning top. It moves along as I throw it; and at the same time round and round as fast as possible, except sometimes when it *sleeps*. Then it does nothing but spin round upon itself, without moving off one spot."

"When it moves round in a circle, and at the same time turns upon its own axis, it may remind you of a planet; and when it *sleeps*, or moves only on its axis, it may remind you of the sun, which you know has a motion of that sort."

"Oh yes. He turns round on his axis in twenty-five days. How long does it take Mercury to turn upon his axis?

"About twenty-four hours and five minutes. Now consider what the effect of this must be to the planet. Having no light of his own, of course it is only the side towards the sun that is lighted up, while the other is in darkness; but by turning completely round once in twenty-four hours, all parts come into the sunshine in turn. Thus in the planet Mercury, as well as in our world, God has separated the light from the darkness, and has given the day and the night to succeed each other."

"Now I begin to understand about day and night," said Mary. "I dare say our day and night come from the same thing. I mean that our world turns round like Mercury, and so we are sometimes in the sunshine, and sometimes in the dark."

"Just so. And our day and night are about the same length as his. This motion of planets is called the *diurnal* or daily motion. But there is also the *annual* or yearly motion. You can tell me what that is?"

"It must be the time they take in going round the sun, I suppose, papa," said Henry. "As Mercury's days are of the same length as ours, perhaps his years are the same too."

"You will not say that, if you look again at the picture of the Solar system, and see how much shorter the journey is which he has to take. He also hurries along with tremendous speed, so that he has performed the whole of his course, and completed the year, in about eighty-eight days. Our year is more than four times as long as his."

"That is very droll. If I could go to visit the people in Mercury, I dare say they would think me twenty-eight years old, for they would reckon by their own years, and four times seven are twenty-eight, you know, papa."

"If there are any people living in that planet, my boy, they must have very different constitutions from ours, to bear the great heat and light."

"Is it so very hot there, then?"

"The heat and light of Mercury are about seven times greater than those of our earth, and would therefore be sufficient to scorch up and destroy the productions of such a world as ours."

"I am very glad we are at such a pleasant distance from the sun, and not in such a scorching place as Mercury," said Mary.

"Depend upon it, the planet is adapted to the situation it is in, and could not do with less light and warmth than God has bestowed upon it."

"What is the distance of Mercury from the sun?" asked Henry.

"About thirty-six millions of miles."

"Not so very near a neighbour, after all, though near enough to find it very hot. What a wonderful sun it is, to send out such a quantity of heat and light!"

"Mercury measures rather more than three thousand miles in *diameter*, that is, across his breadth; and he moves in his orbit round the sun at the astonishing rate of a hundred thousand miles an hour."

"What is meant by his 'orbit,' papa?"

"His yearly path round the sun. The path of each of the planets is called its orbit."

Distance of Mercury from the Sun .	36,000,000 miles.
Diameter	3,200 miles.
Annual Revolution	88 days.
Diurnal Revolution	about 24 hours.
Motion in its Orbit	109,360 miles per hour.

CONVERSATION IV.

THE PLANET VENUS.

Early the next morning, the children saw their papa walking in the garden alone, and they ran down from the nursery to ask for the history of another planet before breakfast. Their papa began thus: "Next to Mercury comes Venus, the most beautiful of all the planets, being the clearest and brightest seen from the earth. Our great poet Milton thus speaks of her:—

> 'Fairest of stars, last in the train of night,
> If better thou belong not to the dawn,
> Sure pledge of day, that crown'st the smiling morn
> With thy bright circlet.'"

"Why does he speak of Venus as crowning 'the smiling morn?' does it ever shine in the morning?" asked Henry.

"Venus, in one part of her course, is seen for more than three hours before sunrise, and in another for as long a time after sunset; this is why she is sometimes called 'the morning star,' and at other times 'the evening star.'"

"Ah, I remember," said Mary, "that was the beautiful star you and mamma were admiring so much one evening. It was so bright it looked almost like a little moon."

"Yes, Venus was then at her nearest point to the earth, and her brilliancy was so great, that I am sure we might have obtained a shadow if we had placed a piece of writing paper to receive it, and had held up some small object in her light."

"Papa, why do you say '*she*' and '*her*' when you are talking of Venus?" asked Robert.

"Because Venus was the name of a heathen goddess. The people who lived in the early ages of the world named the heavenly bodies after their gods and goddesses. If you remember, I spoke of Mercury as '*him*,' and so I shall speak of several other planets, for they are named after male divinities."

"But is it not very wrong to call the planets by the names of those false gods?" said Mary.

"It would be almost impossible, and would cause great confusion, to change the names of the heavenly bodies. Besides, if we refused all names derived from the heathen, we must alter the names of the days of the week, and many other names in common use. Let us be thankful that, by the mercy of God, we have a clearer light than the poor heathen possessed, and can look up to One Almighty Being as the maker and ruler of all things."

"But what did they say about their gods and goddesses?" inquired little Robert.

"Oh, I am not going to give you the history of the heathen divinities. Our time will be much better spent in talking about this beautiful planet. I told you that Mercury is a close attendant on the sun: so also is Venus; though, from her orbit being larger than that of Mercury, she gives us a little more of her presence than he does of his. But as an evening star, she never stays with us more than a few hours after the sun has set; or, as a morning star, shows her face long before his rising."

"I dare say Venus looks very beautiful through a telescope," said Henry.

"She does; and when you see her in that manner, you will indeed say, as Mary did, that she is like a little moon; for her appearance changes in the same way. When she is nearest to us she is in the shape of a crescent, like our new moon; she then appears thirty times larger than when at

can sometimes see only a small part of the bright side of the planet, sometimes half the bright side, sometimes nearly all. But this will be much easier to understand when we come to speak of our own moon, in which all these appearances are so very beautifully shown."

Henry looked at the picture of the Solar System, and said, "Venus seems to be about twice as far from the sun as Mercury is, so I suppose she has a longer journey to take, and does not travel quite so fast."

"She is about sixty-eight millions of miles from the sun, and if you compare that with the distance of Mercury, you will find that she is not twice as far."

"Let me see. Mercury is thirty-six millions of miles, and Venus sixty-eight. If she had been only four millions farther off, she would have been exactly twice as far as Mercury. But that is not much, is it, papa?"

"Not much, do you say? We talk very lightly of these immense numbers, which, after all, it is impossible for us to understand."

"But, papa, I know what a million is. It is ten hundred thousand, and a thousand is ten hundred; so, you see, I can understand a little about it."

"You can talk a little about it, my boy, but neither you nor I can form a true idea of numbers when they reach to millions. But we were speaking of the rate at which Venus moves round the sun. She is slower than Mercury, performing her journey in two hundred and twenty-five days. This is, however, much faster than the earth travels, so that eight years of Venus are equal to five of ours."

"I hope the people (if there are any) do not suffer quite so much from the heat as they do in Mercury," said Mary.

"You persist in pitying Mercury, and its supposed inhabitants," said her father, "though I have told you that the climate and the people are always fitted for each other. The heat and light of the planet Venus are supposed to be about double that of the earth."

"And yet she looks as pale and mild as the moon," said Henry. "You could not fancy it a hot place to be in, could you, papa? But please to tell me whether there is anything else to be seen in Venus, when you look through a telescope?"

"Some spots are visible; but you would not be able to find out what they are. A foreigner, who examined and studied this planet for nearly ten years, assures us that there are lofty mountains on the surface of Venus, and that she is surrounded by an atmosphere fifty miles in height."

"I wish some one would invent a wonderful telescope, that would show us the houses and the people as well as the lofty mountains," said Mary. "It is so provoking not to know anything about them, when we are all lighted up by the same sun, and are travelling just the same kind of journey every year. Now, if Venus should happen to go a little out of her road, and so come nearer to our earth, how pleasant it would be to get a peep at her as she passed by!"

"There is no such thing as going out of the road among the heavenly bodies. Perfect order and beauty belong to the works of God; therefore, no accident of that sort can possibly happen. Both Mercury and Venus at certain times come between the earth and the sun, in such a manner as to appear like dark round spots on the sun's face. This is called their *transit*, or passing over. But in the case of Venus, it happens very seldom. The last time it occurred was in the year 1769, and it will not happen again until the 8th of December, 1874."

"I do not think you have told us how large Venus is?" said Henry.

"She is nearly of the same size as our earth, and measures in diameter about seven thousand eight hundred miles."

Distance of Venus from the Sun	68,000,000 miles.
Diameter	7,800 miles.
Annual Revolution	225 days.
Diurnal Revolution	23 hours 20 minutes.
Motion in its Orbit	80,000 miles per hour.

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[illegible] wish to [illegible] many things relating to this [illegible] which are too difficult for you at present, and would only tire you, if I were to try to explain them. These are the mere beginnings of knowledge which I am giving you, and I leave it to your own industry and perseverance to gain a great deal more another day. You have heard it said that the earth is round like an orange?"

"Yes, papa, I have often heard so but I should not have guessed it from anything I can see. There are hills, and valleys, and plains, and it is very difficult to understand how the world can be round."

"A person standing on the planet Venus," replied his father, "would, no doubt, feel the same difficulty, though we, looking at her from a distance, and through our telescopes, have no doubt about her being a round world. If you could mount to a great height in the sky, and still have power to look down upon our earth, you would see distinctly that she is round. It is the great size of the earth, as compared with our own bodies, that makes the difficulty. But there is a way by which any of us may discover that the earth is round."

"What is that, papa?"

"If we go to the sea-shore and watch the

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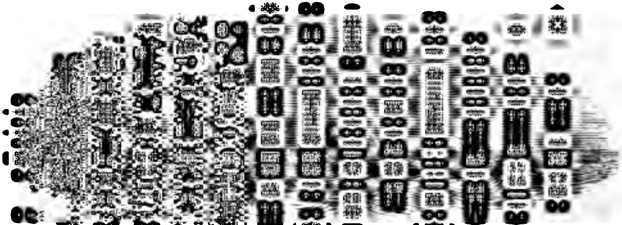

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well raise up our thoughts to Him who 'holdeth the waters in the hollow of his hand,' and who 'layeth up the deep in storehouses.' This law, which is called *the law of gravitation,* I can only attempt to explain to you by saying, that there is a powerful attraction towards the centre of our earth, which prevents us from 'falling off,' as you call it, although the world is constantly spinning round and round. Suppose I were to place a set of small magnets or loadstones in the middle of this orange, where the pips are, they would attract any small steel objects which we might lay upon the orange, and keep them firm in their places, so that they would not fall off, though we were to spin the orange round. This will give you a very faint and imperfect idea of the power which keeps the oceans and rivers, and hills and cities, and people of our earth, from being whirled away into the air while the earth is turning round."

"How wonderful all this is! I cannot feel that anything draws me towards the earth. I can walk, and run, and jump, and I am not at all confined to one place. What *is* this power, papa?"

"I cannot tell you what it is. But you see and feel its effects every day. All falling bodies come downwards, not go upwards. If you throw a stone, it does not fall away into the air, but is sure to come to the ground, although the force you threw it with may send it along for a little while."

"That is because it is heavy," said Robert.

"Certainly, for it is this very power which makes the stone heavy. But suppose a little boy in New Zealand should happen to be throwing a stone at the same time you are. New Zealand is on the opposite side of the globe, nearly under our feet, and if it were not for the power which draws things towards the earth, how could his stone fall to the ground? or how could he stand for a moment in his present position? It is this wonderful attraction that keeps him from falling off into the air. The same power which prevents our bodies from being carried off into space, also prevents all other substances from leaving the earth.

"I hope this power will always keep us in our right places, papa," said Mary. "It is not very comfortable to think of being whirled round, with our heads sometimes upwards and sometimes downwards."

"You will get very different ideas on this subject when you know more about the heavenly bodies. You will then see that the words *upwards* and *downwards* cannot be properly used in the sense you have just given to them. It is indeed desirable, as you say, that we should be kept in our places; for that part of our earth's surface called the *equator*, which is midway between the two poles, turns round at the rate of rather more than a thousand miles an hour."

"And our world is really moving at that rate without our knowing it!" exclaimed Henry. "Why, papa, the journey that you took on the railway by the express train, was like a snail's pace compared with this; and yet we thought that very wonderful at the time. It is a good thing that the earth is so quiet in her journey, and that she does not want any panting, screaming engines to drive her along. But, papa, how can we be certain that she keeps turning round?"

"If the earth simply moved onwards in her orbit, (which she does at the amazing rate of sixty-eight thousand and forty miles an hour,) and if she went round the sun without turning on her own axis, one side of the world only would be lighted up, while the other remained in darkness; that is to say, our day would be a year in duration.

Thus, on the side towards the sun there would never be any night, and on the side away from the sun there would never be any day."

"How very unpleasant that would be," said Mary; "and how much better it is for us to have day and night! It certainly is rather a frightful thing to be turning round so fast; but I am glad of it, if it brings beautiful sunsets and sunrisings, and moonlight and starlight, which is much better than having broad glaring sunshine all the year round."

"I think you can tell me how long the earth takes in turning on her axis, and also in completing her journey round the sun,—by which I mean, how long the day is, and how long the year is?"

"Oh yes, papa; the day is twenty-four hours long, and the year is three hundred and sixty-five days, or very nearly. But while we are taking our journey round the sun, how far are we off from him?"

"About ninety-five millions of miles; but we are sometimes rather nearer to him than that, and sometimes rather farther off. This is owing to the earth's orbit not being round, but oval, as I explained to you respecting the orbits of the other planets. A picture (p. 48) will, perhaps, enable you to understand the nature of the earth's journey round the sun, and the changes of the seasons produced during her course. But you must take notice that the earth is everywhere represented leaning towards one side. I will show you what I mean. Let us take this orange, and call it the earth. The top of the orange we will call the *north,* the bottom we will call the *south,* the right-hand side the *east,* the left-hand side the *west.* Ask mamma for one of her knitting-needles. Now, with her permission, we will run this long needle quite through the orange, from north to south."

"Oh, I see what you are going to do, papa," said Mary. "You are going to make the orange spin round upon its axis, like the real earth."

"Just so. This knitting-needle represents the axis round which our earth is supposed to turn; therefore, we must call this upper end of the needle the north pole, and the lower end the south pole."

"But I suppose the real pole does not stick out at each end like this needle?" said little Robert.

"Certainly not. If you remember, I told you that there is no such thing as a 'real pole;' but it is convenient to speak in this way, to help our understanding of a planet's motion. Now the motion of the earth is never from north to south, but the earth turns round from west to east, just as I am turning this orange now. And you see I do not hold the needle quite upright, but slanting; for that is the constant position of the earth as she turns."

"It is very odd that the earth should lean on one side in that manner," said Mary.

"Odd as it may seem, it is a very happy thing for us, for it is this leaning of the earth that produces the changes of the seasons. If the axis of the earth were quite perpendicular (as I am holding the orange at this moment), we should have no spring, summer, autumn, and winter, but all one season, the same at every part of the year."

"I should not like that at all," said Henry. "There would be nothing to look forward to. I don't think I could spare one of the seasons. Winter, to be sure, is not very pleasant; but then there are the snowballs, and the sliding and skating, and the Christmas fires. So I will not find fault with the earth for not holding herself upright. But I should like to know how it is that, by her just leaning on one side, we

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globe, and *hemi* means *half;* so hemisphere only means half-globe. Let us make a line round our orange in the same way, and call the upper half of the orange the northern half-globe, or hemisphere, and the lower half the southern half-globe, or hemisphere. But I have another 'hard word' for you, which I have already mentioned once: that line which divides the globe into two parts is called the *equator,* though I shall tell you at present nothing more than its name."

"Is there such a line really marked on the world itself?" said Robert.

"No. This line, and many others, which you will see in maps and artificial globes, are only drawn to help our ideas, and to express certain appearances in the heavens."

"Which of the hemispheres do we live in, papa?" asked Henry.

"The northern; and if you remember this, and look again at the picture, you will, perhaps, understand a little about the change of our seasons. The globe at the top of the picture shows the position of the earth about the 21st of March, or our spring. At this season the northern and the southern hemispheres get about an equal share of heat, for the sun shines full on the equator, and is at an equal distance from both poles. As the earth proceeds on her journey, from east to west, she arrives about the 21st of June at that part of her orbit shown on the left of the picture."

"But, papa, can that be summer? She is farther away from the sun than she was in spring."

"True. But look at the northern hemisphere, and see how much more it is now turned towards the sun than it was in spring. You must remember that it is our own northern spring and summer I am talking about. If we lived in the southern hemisphere, our seasons would be very different. There is also another reason why it is summer with us when the earth has reached this part of her journey. The rays of the sun then fall nearly in a *direct line* on the part of the earth we live in; and therefore have much more power than when they fall in a slanting manner. We get much more heat from a fire by sitting in front of it than at the side, and we get much more heat from the sun when we are opposite to him than when we receive his light sideways."

"I understand that, papa," said Henry; "but I cannot help being surprised that we are farther off from the sun in summer than at any other part of the year, for so it seems to be in the picture."

"It is so: though we are not so much farther off as it appears in the picture. At the bottom of the picture is the earth at that part of her orbit which she reaches about the 23d of September, or our autumn. She is then in the same position as in spring; and the sun again shining full upon the equator, gives equal light and heat to both hemispheres."

"But it is generally warmer in autumn than in spring, is it not, papa?" remarked Mary.

"Much warmer. And the reason is, that the earth itself has become so much heated during summer, that it keeps part of its warmth; and this, added to the heat of the sun, produces the fine harvest weather we often get in September. The earth then gradually proceeds, until on the 21st of December she is in the position shown on the right of the picture, and it is then our winter. The northern hemisphere is, you see, turned away from the sun, and only enjoys those slanting rays which give very little heat. Thus, although we are much nearer to the sun than we were in summer, we get much less of his heat. The inhabitants of the southern hemisphere now get their summer, so that our countrymen who have emigrated to Australia are enjoying Midsummer, while we are gathering round our Christmas fires."

"How odd it must seem to them to have their hot weather in December!" said Robert.

"Yes; and especially when they first arrive. After having left summer behind them in this country, it must appear very strange, at the end of a five or six months' voyage, to find a second summer glowing upon them in that distant land."

"There is one thing you have not told us about, papa," said Henry; "the reason why the days are so much longer in summer than in winter."

"I think you will see how it is, if you look attentively at the figures of the globe in the picture. One half of each globe is lighted up at a time; those places which have their pole turned towards the sun, will have their days longer than their nights; and those which lie in the opposite hemisphere will have their nights longer than their days. In summer, when our hemisphere is turned towards the sun, the darkness cannot last so long as in winter, when it is turned away from him. See how much less shade there is in the northern hemisphere of this globe on the left, than there is in that of the globe on the right. In spring and autumn the days and nights are nearly equal. If you remember, also, that the inclination or leaning of the earth is always just the same, you will see that during our summer the North Pole is never in darkness; for, though the earth turns round every day, a small space at the top of the globe, just by the pole, never comes into the shade."

"Yes, I see it is so in the picture of the earth in summer, but in winter it seems to be always dark."

"You are right; and if you observe, it is just the reverse at the South Pole. While there is one long day in the north, there is one long night in the south. Near the poles, there is but one day and one night in the year, each being six months long."

"What a dismal place to be in!" exclaimed Mary. "The more I hear about other parts of the world, the better I like our own."

"I hope you will always feel so; I should wish you to have a strong love of country and of home. But you must not think a place dismal or miserable because it is not like what you are accustomed to."

"But how can it be anything else but dismal, papa, to have such a long, long night?"

"The long night is not so gloomy as you may suppose. In those countries, ice and snow are always on the ground, and these reflect light in a remarkable manner. The moon and the stars also shine with great brilliancy, and the sky is frequently lighted up with the splendid Aurora Borealis, or northern lights, so as to appear covered with yellow and green and purple flames."

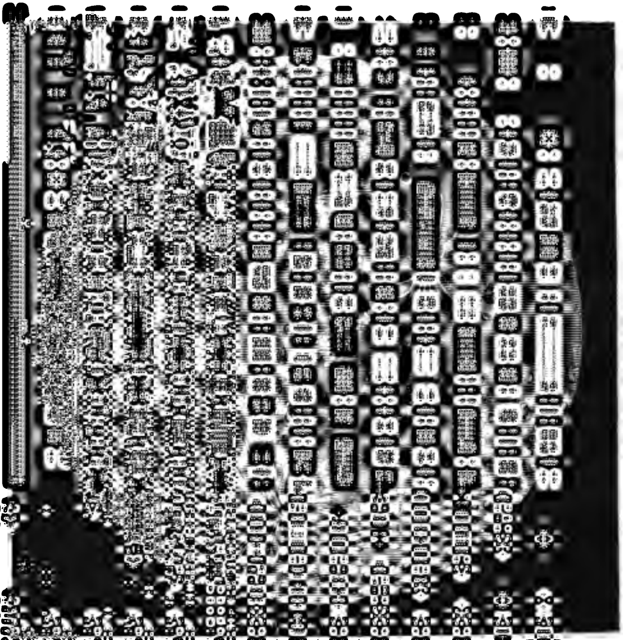
"Oh, if that is the case, they are nearly as well off as if they had the sun," said Mary.

"And so you will find it, always. If a country is deprived of important advantages which other countries enjoy, there is sure to be something bestowed upon it which makes up for the loss; so that among every nation and people on earth, the kindness and care of our all-wise Creator are fully displayed. I have now told you as much as you will be able to understand at present about the earth; and as our conversation has been rather a long one, we will leave the moon to be described another time."

"I have been reading some verses on the Solar System," said Henry, "but I do not understand the meaning of one of the words. What is the Sun's *gravitation?*"

"Gravitation is the name given to that very power which we have been talking about, and which keeps all things in their right places. This kind of power exists in the sun as well as in the earth, and much more strongly, for by it he attracts all the planets of the solar system, notwithstanding the immense space between the sun and some of the planets."

Distance of the Earth from the Sun,	**95,000,000 miles.**
Diameter, from Pole to Pole . .	**7,899 miles.**
Diameter at the Equator . . .	**7,926 miles.**
Annual Revolution.	**365 days, 5 hours, 48 min.**
Diurnal Revolution	**23 hours, 56 min. 4 seconds.**
Motion in its Orbit	**68,040 miles per hour.**



CONVERSATION VI.

THE MOON.

The next evening, the children went for a long walk, to gather wild flowers for their mamma. Just as they reached home, the moon was rising above the trees, and they remembered that their papa had promised to talk to them about what he called " one of the most beautiful and interesting objects in nature."

When they had found him, and assured him that it wanted yet an hour of their bed-time, he went with them into the garden, and Mary said, " I suppose Mercury and Venus do not want moons, because they are so much nearer the sun than we are? I am glad we have a moon, for it would be very gloomy without one."

" But it would be still pleasanter," said Robert, " if our moon was always shining from one year's end to another. Do you know what the moon is made of, papa?"

" The moon is a solid globe, like the planets, and she does not shine by any light of her own. All her light is gained from the sun, and is reflected back from her surface, just as it is from Venus and the rest of the planets."

"I do not exactly understand, papa," said Mary, "how the moon and the planets can get their light from the sun; for they shine when the sun is gone down, and quite out of sight."

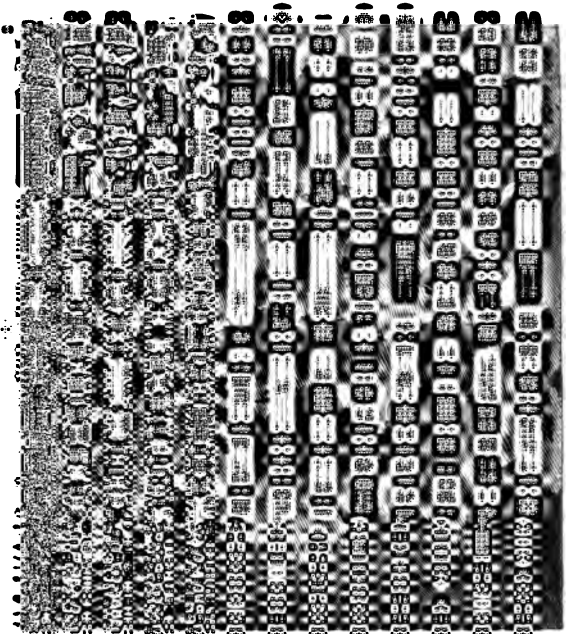
"He is gone down to *us*, but not to them. You must look at the picture of the solar system again, and see how small our earth really is. You will not then fancy that when it is dark with us, it must be dark also with the other planets. We do not interfere with their share of light, nor they with ours, except when it sometimes happens that our earth comes in a direct line between the sun and the moon, or the moon comes in between the sun and the earth. We then have an *eclipse*. But since you wish to know what the moon is 'made of,' here is a picture of its appearance when seen through a powerful telescope. Even with the naked eye you can see some markings on the moon's bright face; but through a telescope they appear much plainer, and seem to be hills and valleys, scattered very thickly over the country. Some of the valleys are thought to be three miles deep, and they are surrounded by sharp bright ridges, which we hardly know how to account for. The bright spots are supposed to be the tops of lofty mountains, lighted up by the sun."

"It must be a very hilly country, indeed, papa," said Henry. "Have any rivers and seas been seen in the moon?"

"The more-smooth and regular parts of the moon were once thought to be covered with water, but they are now supposed to be merely large flat plains, and they have even been seen to be of a bright green colour. Yet it is difficult to suppose that the green colour can be that of trees or herbage, for it is now generally believed that there is no water in the moon."

"No water, papa!" cried Henry. "Then there can be no people living there, for no one could live without water. But how can any one possibly tell that there is no water in the moon? There may be a great many little brooks and rivers, too small to be seen through the telescope."

"If there were rivers and brooks, there would also be mists and vapours; but the moon seems to be without these, and to have little or no atmosphere. Therefore we may naturally conclude that



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she is without inhabitants, or that they must be altogether different from ourselves."

"What a strange country!" said Mary. "It cannot be so beautiful as it looks at a distance."

"I am not at all sure of that. Persons who have studied the moon attentively through a powerful telescope, assure us that they can discover a rich looking and beautiful level country, as well as an extensive district of mountain peaks and volcanoes. Yet how the country can be rich without water, is indeed a mystery. The mountains in the moon have been so plainly seen, that maps have been made of them, and names given to them. One very brilliant rock, about half the height of our loftiest Alps, is called Pico; some mountain ranges are called the Apennines, the Caucasus, and the Alps, and the mouths of volcanoes are also known by distinct names. This picture represents a part of the moon, where there are large caverns, supposed to be the mouths of volcanoes, and these are so close together as to give a very curious appearance to the district. Such are the wonders discovered on this side the moon; we do not know what the other side is like."

"How is that, papa?" asked Henry. "Does not the moon turn round, so as for both sides to be seen?"

"It is remarkable that the moon turns round on her own axis only once in a month. She also performs her journey round the earth once a-month, and at the same time accompanies our planet in her orbit round the sun."

"Then the moon's days are a month long," said Henry.

"Yes, and her annual course round the sun is in a sort of curling line, because she has to go round the earth, as well as to complete her own journey. Now, it comes to pass from these various motions, that the same side of the moon is always turned towards the earth. You will understand this better when I take you to see what is called an *Orrery,* where a number of globes, representing the planets and their moons, are set in motion, and turn on their own axes, while they travel round a large globe fixed in the centre, representing the sun."

"I should like to see that, very much," said Mary. "And still better, I should like to look through one of those large telescopes, and see the mountains and the green fields in the moon. No wonder we always see those dark parts that look something like an old man's face in the full moon. If the moon turned round a little faster, we should only see them sometimes, when they happened to be turned this way."

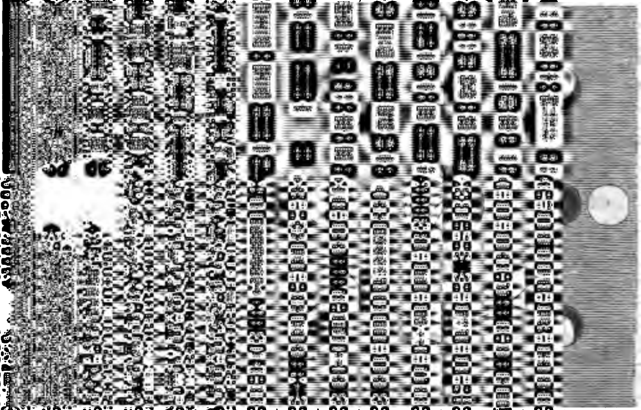
"If there are inhabitants in the moon," said her papa, "our own earth must be a beautiful and wonderful object to them. It appears to them about sixteen times larger than the moon appears to us; and turning round at what must seem to them an astonishing rate, we must form the most interesting sight in their heavens."

"Does our earth look light or dark to them, papa?" asked Robert.

"It most probably goes through all the same changes we see in the moon, only, being so much larger, they must present a most splendid appearance."

"Do you mean, papa," said Henry, "that the earth is sometimes like a new moon, sometimes like a half moon, and sometimes like the full moon?"

"I do: and a brilliant light we must cast when at the full. If there are any people inhabiting the other side of the moon, it must be well worth a long journey to this side to get a peep at the earth."



"Here is a picture which may possibly help you; but the changes of the moon are best shown by an orrery. All the small globes represent the moon in different positions, and under different appearances; and the globe in the centre is the earth. The globes of the inner circle show how much of the moon is lighted up by the sun, and those of the outer circle show the appearances of the moon to us, at different times in the month. Suppose the moon to be at that part of the circle nearest to the sun, the bright side is then completely turned away from the earth, therefore we do not see her at all. This is new moon, and is shown by the black globe nearest the sun. But let her advance in her journey, and in about three days and a half, a small part of her bright side comes into view. One half of the moon is still lighted up by the sun, but as we see only a little of it, the moon appears to us as a cresent, which is shown in the picture. The two points of the crescent are called the moon's *horns* or *cusps*. When she has performed the first quarter of her journey, we see one-half of her bright side; and when she has travelled a little farther, nearly the whole of her bright side is seen from the earth; she is then said to be *gibbous*, which means, that she curves outwards. In three days and a half more, she has her bright side turned full towards us, and is then our full moon."

"Ah, that is the pleasantest part of the month, papa," said Mary. "I wish it lasted a little longer."

"Although we call the moon full at that time, a very small part of its bright side is lost to us, because it is always a little above, or a little below the straight line joining the earth and the sun. If it came exactly in a line, there would be an eclipse, as I shall presently explain to you."

"And yet the moon looks quite round, papa, when it is at the full," remarked Henry.

"The part we lose is so small, that it leaves the moon very nearly a perfect circle; yet there is always a very slender crescent lost to us, either on the upper or lower part of the moon, according as she is above or below the line I have mentioned. Soon after the moon has attained the full, she begins to *wane*, that is, to become less bright and apparently smaller. She then gradually comes into these positions shown in the picture, and has nearly the same appearances as when she was on the increase. She soon reaches her last quarter, as it is called, and shortly afterwards her appearance is again that of a faint crescent of light. Soon after this she becomes invisible, and is once more called New Moon."

"Then it seems, papa, that the moon is *really* always full, only we cannot see her bright side at all times," said Henry.

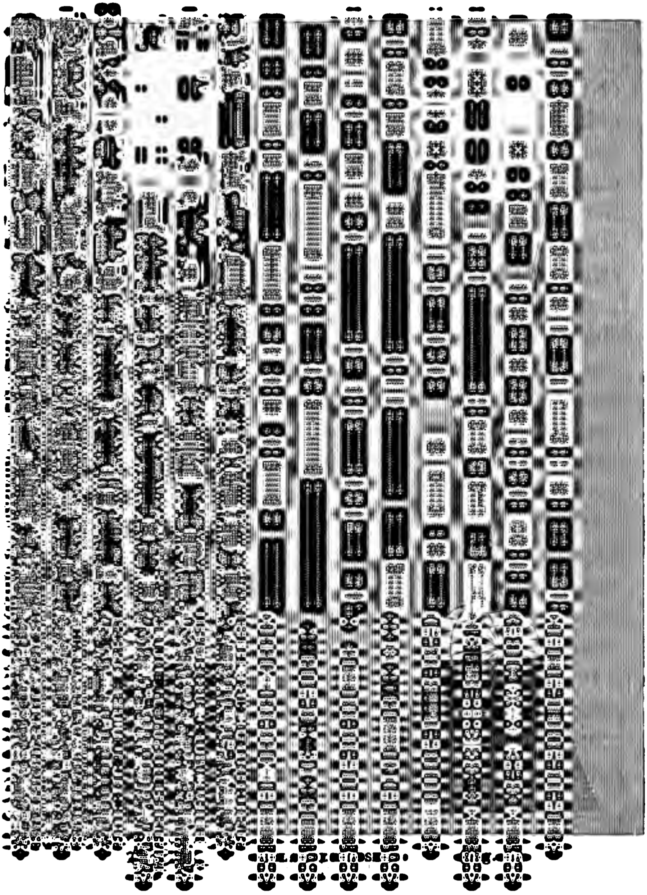
"Certainly. By day as well as by night, and from one year's end to another, the sun lights up the moon and all the planets. If it were not for the bright light of the sun, we should see all the heavenly bodies in the daytime as well as by night; and, notwithstanding his brightness, the moon sometimes manages to show her face by day."

"Oh yes, papa," said Mary; "I saw the moon one day at twelve o'clock, but I could scarcely believe it was the moon, she looked so pale and dull. It was so odd to see her when the sun was shining."

"Do you think you now understand better the reason of the changes of the moon?"

"I think I do, papa," said Henry. "This picture has made it much easier to me."

"Very well. These changes are called the moon's *phases,* or appearances."



"How far is the moon from us, papa?" inquired Mary.

"About two hundred and forty thousand miles. But her orbit is oval as well as that of the other heavenly bodies; so that she is sometimes several thousand miles nearer to us, and sometimes several thousand miles father off."

Henry now reminded his papa that he had said he would tell them something about eclipses.

"I did," answered his father; "and here is a picture which will teach you better than words. It represents two kinds of *solar* eclipse, which means, eclipse of the sun. The white globes represent the sun, and those partly in shadow the earth. The small globes are intended for the moon, coming in an exact line between the sun and the earth. Now if the moon were not there, the sun would shine full upon the earth, but the moon coming between, casts a shadow on the earth, and causes the sun to be partly or entirely hidden from those beneath it, according as the shadow is lighter or deeper."

"What is the reason that the shadow cast by the moon is so much darker in the middle than at the sides?" asked Henry, as he looked at the picture.

"The shadow in the middle covers a space which is entirely without the sun's light, and where the eclipse is, therefore, total; but the shadow at the sides falls on a space where part of the sun can be seen, and where the eclipse is, therefore, only *partial.* A total eclipse can only take place when the moon is at her nearest to us, and when the sun is farthest off." (Fig. 1, page 68.)

"I dare say," said Mary, "that is the kind of eclipse old Mary Jones talks about, which she saw a great many years ago, and was so frightened at."

"A total eclipse," said her father, "is often viewed with terror and superstition by those who are ignorant of its cause. In ancient times the sun and moon were regarded as deities, and worshipped under the names of Sol and Luna. When an eclipse of either of these bodies happened, the poor idolaters supposed their god to be angry, and hastened to offer sacrifices and prayers."

"And what did they think when the eclipse was over?" said Robert.

"They rejoiced in the thought that their god had heard their prayers, and accepted their sacrifices, and was again showing them the light of his or her countenance, for Sol was a male divinity, and Luna a female."

"Poor things!" exclaimed Mary, "how sad for them to worship the sun and moon, which could not hear their prayers, nor do them good or harm, except as God chose."

"Very sad indeed. But even in this Christian country a total eclipse is apt to terrify poor ignorant persons, and make them suppose that something awful is going to happen to the nation. There is another sort of solar eclipse, in which the *dark* shadow of the moon does not reach the earth at all, and the eclipse is therefore not complete. Fig. 2, in the picture, (p. 68,) represents it. In this case the moon is at her greatest distance from us, while the sun is at his least distance from us; the dark shadow of the moon, therefore, falls short of our earth; but persons standing immediately on the spot where the shadow would have fallen had it been a little longer, see the dark body of the moon nearly covering the sun's face. I say *nearly*, because a ring of the sun's light is left all round the dark moon. In a total eclipse, the moon being near to us, appears larger than the sun, and completely covers him; but in this kind of eclipse, the moon being farther off looks less, and does not entirely cover the sun. This second kind of eclipse is called an *annular* eclipse."

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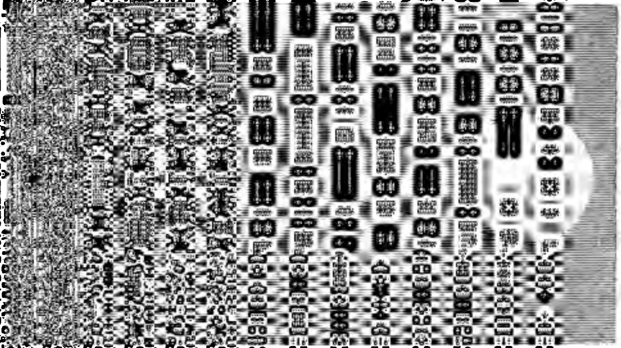

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nearly so. But when the moon is not entirely within the dark shadow, only a part of her surface is eclipsed."

"That was the sort of eclipse I stayed up late to see, one night," said Henry. "First a kind of mist came over part of the moon, and then came a blackness, that seemed to blot out a large piece of the moon's face."

"The mist you speak of was that lighter shadow you were asking about just now, and the blackness was the deep shadow where no rays of the sun can penetrate at all. These two kinds of shadow are called the *umbra* and the *penumbra;* the first of which means a *shadow*, the second a *partial shadow*."

"Eclipses are very beautiful," said Henry; "I wish they happened oftener. Is there one every year, papa?"

"There are generally about four every year; two of the sun and two of the moon. There cannot be less than two, or more than seven."

Henry was very much astonished to hear that there were so many eclipses; and inquired how it was that we did not see them oftener. His papa explained to him that an eclipse may happen many times without being visible in the part of the world we live in: and that even when it does happen in our part of the world, the weather may be cloudy, so as to prevent our seeing it.

"There is another subject," continued his father, "that I must say a few words about, in connexion with the moon. Do you remember when we were by the sea-side last summer, how pleased you all were to watch the rising tide?"

"Oh yes, papa," said Mary. "We went down to the beach to see it come in, every day."

"At what time of the day?" said her father.

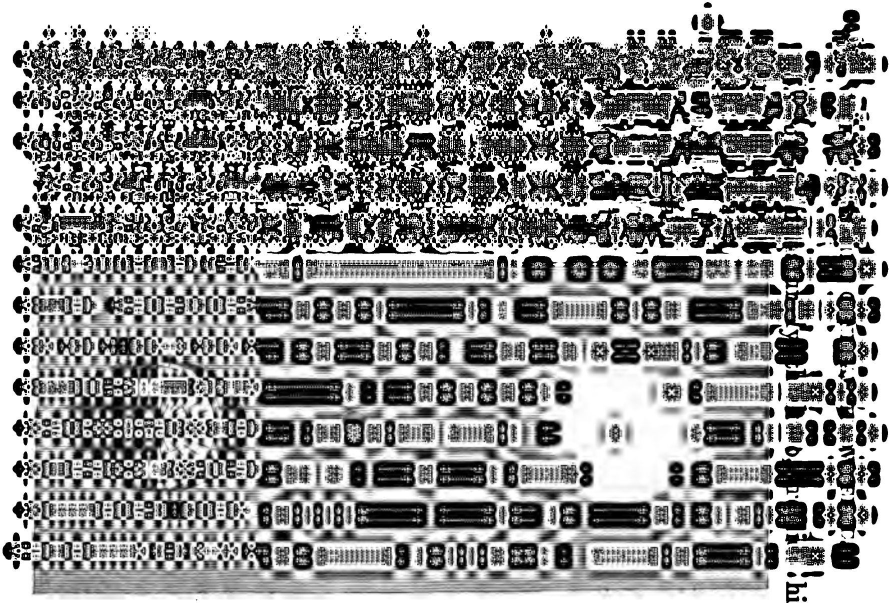
"At different times, papa," answered Mary; "for the tide did not come in at the same hour every day, but later and later."

"Just so. This rising of the waters is caused chiefly by the attraction of the moon, and as the moon comes to the south of us every day later than on the day before, so the high tide at any place is later every day in the same proportion."

"And is the moon really able to lift up the waves of the sea, papa?" said Henry.

"She helps to do so," said his father. "The Great Ruler of the universe has given the moon a certain influence over our earth, and it is beautifully shown in this regular movement of the waters of the ocean. The sun also attracts the waters of the earth, but much less powerfully, on account of his great distance from us. When the sun and moon and earth are in a line, which happens at new and full moon, the tides are highest, because the sun and moon are both acting on the same points; but when the moon is at the quarters, her attraction is felt on one portion of the waters while the sun's attraction is acting on another portion, and thus the tides are prevented from reaching so great a height. Here are two figures, one to represent the high tides at new and full moon, which are called *spring tides*, and the other to show the lower tides, which take place at the first and last quarter of the moon, and are called *neap tides*."

The children examined the pictures, and saw that the shaded part was intended for the waters raised up by the sun and moon; but Henry soon found something which he could not understand. "How is it, papa," said he, pointing to the representation of the spring tide, "that the waters rise up on both sides the globe? It surely must be a mistake of the person who drew the picture; for if the sun and moon drew up the waters on one side, that would make them sink on the other side."



SPRING TIDE.

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[illegible] said [illegible] planet, [illegible] travels round his orbit unattended by any moon, although, being farther from the sun than we are, we should have expected him to be accompanied by two or three moons."

"How very dark the nights must be!" said Mary. "I hope the people in Mars know how to light up their streets and houses well, or it must be very gloomy."

"How do you know, Mary," said her elder brother, "that they have not the Northern Lights, or some such beautiful thing in their sky, to serve instead of the moon?"

"Ah! I forgot that," said the little girl; "but whatever light they may have, it must be rather cold there, at the distance they are from the sun."

"You are right, Mary," said her father. "Mars is supposed to enjoy only half the light and heat which we get. And there is every reason to believe that its poles are covered with snow; for the planet, when seen through a good telescope, has the appearance of the smallest globe in the picture. There are white patches at the two poles, and these become fainter when long exposed to the sun, and brighter again when turned away from him."

"Why is that globe made so small, and the others so large, in the picture, papa?" said Mary.

"To show that Mars appears of different sizes, according as he is nearer or farther away from the earth. This planet can never come between the earth and the sun, as Venus and Mercury do, because its orbit is outside that of the earth."

"Then there can never be a transit of Mars," said Henry, who remembered what his papa had said about the transit of Venus.

"No; nor can Mars ever appear crescent-shaped like the new moon; but he sometimes has only three parts of his bright surface towards us, as you see in the third globe in the picture."

"And what do those dark marks mean in the fourth globe?" said Mary.

"They are supposed to be the shadows of mountains; and by their means we know that Mars has a motion on his own axis of about twenty-four hours, and thirty-nine minutes."

"How can the mountains tell us that?" said Robert.

"I can explain it," said Henry; "for papa told me about the spots in the sun, and how they show that the sun turns round. Look at this ball of mine, Robert. You see I am making some lines upon one side of it, something like the mountains in Mars. Well, if I turn the ball gently round, the mountains go out of sight; but if I keep on turning, they come into sight again. So I dare say it is in Mars; and if people reckon up the time the mountains take to go away and come back to the same place again, they know how long Mars is in turning quite round. Is not that it, papa?"

"Quite right," said his father. "In this way we find that the length of the day in Mars, is rather greater than with us. The years are much longer than ours; for Mars revolves round the sun in 686 of our days. His distance from the sun is about 143,000,000 of miles."

"You called him a red-looking planet, papa," said Mary. "What is the reason of his being so?"

"Something peculiar in his atmosphere most probably causes this appearance. This planet is only about one-fifth of the size of our earth."

Distance of Mars from the Sun,	143,000,000 miles.
Diameter	4,189 miles.
Annual Revolution	686 days.
Diurnal Revolution	24 hours, 39 minutes.
Motion in its Orbit	53,000 miles per hour.

THE ASTEROIDS.

"As you have not been long telling us about Mars, papa," said Henry, "will you let us know something about the little planets that come next to him?"

"Certainly. These small planets were called *Asteroids*, because they had the appearance of *stars*. They have all been discovered since the commencement of the present century, and four of them since the year 1845. The names of the Asteroids longest known to us are, Vesta, Ceres, Pallas, and Juno, while the four newly discovered are called Astræa, Flora, Iris, and Hebe, all being named after heathen female divinities. The orbits of the Asteroids are all near each other, and about mid-way between the orbits of Mars and Jupiter."

"Will you show us these planets, papa?" said Mary. "It is a fine clear evening, and I dare say we shall be able to find them, if you will tell us where to look."

"You cannot see them at all with the naked eye," said her father; "and even with a telescope you would not discover them, unless you had an instrument of high power."

"I am very sorry for that," said Henry. "I thought they would make such a pretty cluster of stars to look at."

Henry was here told that these planets do not form a *cluster*, nor move round the sun quite at the same rate; so that they are often at a distance from each other.

Mary wished to know the size of each little planet, and the length of its day and year; but her father told her that the length of the day cannot be ascertained, and the size of the planet is a matter of uncertainty, on account of their distance, and the impossibility of observing them fully. "Their years," he said, "are about four times as long as ours, on account of the larger orbit in which they travel; and as to their size, many astronomers are of opinion that the largest does not measure more than two hundred miles across, and that the smallest is not seventy miles across.

"What pretty little worlds they must be!" said Mary. "Do you think, papa, that there are any people living in them?"

"It is not impossible that these little planets are inhabited," said her father; "and if so, it may be in the power of the people to change their position according to the season, and so, if it please them, to live in a perpetual summer."

"How very convenient," said Henry, "to be able to avoid all the bad weather. And then, papa," added he eagerly, "how pleasant it must be, if they find it too hot on one side, to go to the other and have a slide on the ice! Oh, how I should like it!"

"Seventy or eighty miles would be rather too far to go for a slide," said his father. "And if the people are as small in proportion as their planets, such a journey may be as formidable to them, as a voyage to New Zealand would be to you. Besides, we must not take it for granted that they *have* any ice. They may have so rapid a daily motion as to prevent extreme cold, and at any rate, they may not have the same means of moving from place to place that we enjoy."

"No; they certainly cannot have railroads in those little worlds," said Mary.

Henry and Robert laughed at the idea of a railroad in Pallas, or Vesta, or Juno, and thought that there need be only one terminus for a whole world of their size, as a train leaving the principal town, might go round the world and come to the same spot again in a few hours. Mary wished to know whether any one had been able to discover seas or rivers in these little planets, or whether, like our moon, they seemed to be without water. She was told that nothing is known of the surface of these planets, but that Pallas is said to have a very hazy and extensive atmosphere, giving her a ruddy appearance.

"It is very odd," said Henry, "that these planets should be so much smaller than all the rest."

"It is remarkable," said his father; "and as they come just in that part of the solar system, where we might have expected to find a planet of similar size to the rest, some persons imagine that these small planets, whose orbits are so close to each other, are only the fragments of some larger planet which once occupied their place in the heavens."

The children cried out with surprise at this strange notion, and hoped it was not the true one, for they thought if one of the planets had already been broken into small pieces, our own turn might come next, and this beautiful world be split asunder, and made into smaller planets. Their papa quieted their fears, by reminding them that we are in the hands of the same Almighty Being who created all these things, who sent forth the planets in their appointed orbits, and who sustains the whole universe in its wonderful order and beauty, and that by the revelation he has mercifully bestowed upon us, we are encouraged to trust Him as a gracious and compassionate Friend.

DISTANCES OF FOUR OF THE ASTEROIDS FROM THE SUN.*

Vesta	223,000,000 miles.
Juno	250,000,000 „
Ceres	260,135,000 „
Pallas	260,145,000 „

ANNUAL REVOLUTION.

Vesta	1335 days 4 hours.
Juno	1591 days.
Ceres	1681 days 17 hours.
Pallas	1681 days 17 hours.

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* The distances from the sun of the newly-discovered Asteroids, Flora, Iris, Hebe, and Astræa, have not yet been satisfactorily determined. A ninth Asteroid has been announced, as discovered in April, 1848, but is yet unnamed.

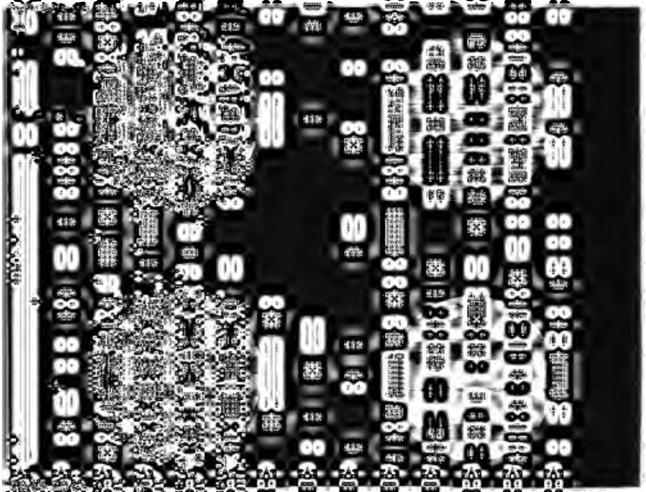
CONVERSATION VIII.

THE PLANET JUPITER.

As soon as the planet Jupiter became visible in the heavens, it was pointed out to the children as the largest and brightest in the solar system, to which no other planet can be compared, except Venus, who appears almost as brilliant when at her nearest to the earth. They were astonished to hear that Jupiter takes nearly twelve of our years to perform his journey round the sun, and that he is about thirteen hundred times larger than the earth.

"What a splendid planet!" said Henry. "I hope I shall see him through a powerful telescope some time or other. If Venus looks so beautiful through a telescope, I dare say Jupiter does also."

"Jupiter is even a more interesting object than Venus," said his papa. "He does not, indeed, appear in different *phases*, as Venus does, because his orbit is exterior or outside that of the earth; but when viewed through a telescope, he appears [illegible] you [illegible]



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[illegible] dif- [illegible] of [illegible] ght [illegible] there are only two or three of these belts, at other times there are seven or eight; sometimes they continue unchanged for two or three months, at other times they alter their appearance in the course of an hour. But the prettiest sight connected with this planet, is the revolving of his four little moons, which can be most distinctly seen by means of the telescope."

"Four moons!" said Robert. "How pleasant the evenings must be in Jupiter, with such plenty of light!"

"Jupiter must greatly need the light of these moons," said his papa, "for his distance from the sun causes him to have only one twenty-fifth of the light which we enjoy."

"And is it very cold there, too, papa?" asked Mary.

"It is probable that the cold in Jupiter is not very severe."

"I cannot think how that can be, papa," said Henry, "unless the moons give heat as well as light."

"No," said his papa, "Jupiter's moons have no more power to warm that planet than our moon has to warm this earth. But Jupiter himself wheels round upon his axis at the astonishing rate of about twenty-six thousand miles an hour, which is more than twenty-five times faster than this earth. This rapid motion brings the greater part of the planet quickly under the influence of the sun. But there is another remarkable circumstance which affects the climate of this planet. You remember, when we were talking about the earth, I explained to you how it is that the changes of the seasons are produced."

"Oh yes, papa," said Henry, "they are all caused by the earth leaning on one side, and not carrying herself upright."

"And what did I tell you would happen, if the earth did 'carry herself upright,' as you call it?"

"Then there would be only one kind of season, and the days and nights would always be of the same length."

"Right. Now this is just what happens in the planet Jupiter. The axis of Jupiter does not incline like that of the earth, but is quite upright as he pursues his journey. Therefore he is not subject to the changes of season we experience; his days and nights are equal; and supposing him to have a very dense atmosphere, the heat may be nearly equal to that of our earth."

Mary wished to know whether Jupiter's four moons were near together, and all gave their light at once, or whether they shone on different sides of the planet. She was told that they all revolve round the planet very quickly, but each at a different rate; the first performing its journey in one day and eighteen hours; the second in three days, thirteen hours; the third in seven days, three hours; the fourth in sixteen days, sixteen hours.

"How fast they must go!" said Henry. "Not one of them is so long on the road as our moon, although they have such an enormous planet to travel round. Are they near to him, or at a great distance?"

"The nearest is twenty thousand miles farther from Jupiter than our moon is from us, and the other three are at greatly increasing distances."

"And how large are they, papa?" asked Robert.

"They are about the size of our earth; some being a little larger, some a little smaller."

Mary was quite surprised to hear that they were so large; for, owing to her papa having called them "little moons," she had fancied them smaller than the moon which lights our world. He told her that they are small compared with Jupiter himself, although large compared with our moon. He also mentioned that these four moons were the first discovery ever made with the telescope. Galileo, the man who invented the telescope, having made a very rude kind of instrument out of an organ-pipe, turned it towards Jupiter, and saw a small star near that planet. At different times afterwards he discovered three other stars, and found that they all revolved round the planet, sometimes coming in front of his bright face, then travelling to one side, and afterwards passing round behind him, and appearing again on the opposite side.

"How delighted he must have been to find that out," said Henry; "and what a good thing for us, and for every one, that he discovered the way to make a telescope! Were not the people very glad about it, and did not they crowd round him to look through the wonderful instrument?"

"No doubt there were many that rejoiced with Galileo, at his noble discovery; but you will be surprised to hear that there were others who thought him a wicked and artful man, a dealer in magic. These persons imprisoned him, and dealt very harshly with him, thus showing their own ignorance, and leaving the name of Galileo to be a remarkable instance of suffering in the cause of science."

"Poor Galileo!" said Henry, "I am very sorry for him, and I shall always think of him when I look at Jupiter. Galileo little thought what trouble it would bring him when he contrived his telescope, and first turned it towards that planet."

"And he little thought also of the vast importance of his discovery. Could he have foreseen the wonderful things which would be revealed by means of telescopes, and the great increase of knowledge they would bring to the world, I have no doubt he would have been so transported with joy as to think very lightly of his own sufferings, and even to consider them an honour."

"How long ago was this discovery made?" said Henry.

"About two hundred and thirty-six years," replied his father. "Since that time, the telescope has been greatly improved, and a world of wonders revealed to us by its means. With a good telescope, we can even discern the eclipses of Jupiter's moons, notwithstanding the immense distance which separates us from that planet."

"Oh! do tell us about Jupiter's eclipses, papa," said Robert.

"Eclipses are very numerous in that planet. The orbits of three of Jupiter's moons correspond so nearly with the orbit of Jupiter himself, that every time either of these moons is new, or comes between Jupiter and the Sun, there is an eclipse of the Sun to the inhabitants of Jupiter (if there are any); and this we are able to discover in the form of a faint shadow, passing over the face of the planet, as the moon comes between him and the sun. But the eclipses we can see best are those of the four moons themselves, which are very often passing into the shadow of Jupiter, behind the body of the planet, and thus becoming eclipsed. It is a most interesting sight to watch the movements of these moons, which sometimes appear in a straight line on one side of the planet, at other times, part on one side, part on the other. By watching them for a few hours you may see them change their positions, and after a while, one or the other will pass into the shadow of the planet and become eclipsed."

"And when the moons pass over the face of Jupiter, can we see them still?" inquired Henry.

"Not always; for they are bright like the planet, and can seldom be distinguished; but in passing before him they sometimes cast shadows on his face, which can be distinctly seen by means of good telescopes, looking like small round ink-spots."

"Do the moons turn round on themselves, papa," said Mary, "as well as travel round Jupiter?"

"Certainly. And it is curious that, like our moon, they turn on their axes only once in the time they revolve round their primary planet. I have nothing more to tell you about Jupiter, except that, like Venus, he sometimes appears as a brilliant 'morning star.'"

Distance of Jupiter from the Sun . .	489,000,000 miles.
Diameter.	87,000 miles.
Annual Revolution	4,332 days 14 hours.
Diurnal Revolution	9 hours 52 minutes.
Motion in its orbit	25,000 miles per hour.

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[illegible] Saturn, [illegible] had [illegible] by a [illegible] what, this ring could be made of, or what was the use of it. When their papa was at leisure to attend to their questions, they began to ask him many things about Saturn.

"Until about seventy years ago," he replied, "Saturn was supposed to be the most distant of all the planets, being about nine hundred millions of miles from the sun. The planets Uranus and Neptune had not then been discovered, therefore poets and other writers spoke of Saturn as the boundary of the solar system."

"I suppose Saturn gets very little light and heat from the sun, papa?" said Mary.

"Only one-eightieth part of what we enjoy; but there is a provision made for lighting him in his distant journey. He is attended by seven moons, and is also surrounded by a most remarkable ring."

"And does the ring give light to the planet?" inquired Henry.

"No doubt it does," answered his papa. "It gives to the planet the borrowed light which it receives itself from the sun."

"But what is the ring made of, papa?" said Robert.

"That I cannot tell you. Its appearance changes so much, that persons observing it at different times have given very different accounts of it. It appears to be a solid body, for it casts a shadow on the planet, and, according to the position we see it in, it is either like a mere line across the body of the planet, or like an oval ring. Sometimes it is scarcely visible at all."

"I wonder whether it is fastened to the planet in any way," said Mary; "if not, I cannot think how it is that it stays in the right place. You would think that Saturn, as he went round, would slip out of his ring, and leave it far behind."

"The ring is so far from touching the planet, or being fastened to it," replied her father, "that its inner edge is more than nineteen thousand miles away from Saturn. And as to getting out of its place, you must know that this ring has a rapid motion of its own, by which it revolves round Saturn in about ten hours and a half. The force with which it revolves keeps it at an equal distance from the planet, and the attraction of the planet prevents it from being left behind."

The children wondered more and more what this ring could be, and looked at the picture with great curiosity. They inquired the size of Saturn, and found that it was nearly a thousand times larger than our earth.

" Oh, what a tremendous ring," cried Henry, " to go round such a world, and yet not come nearer to it anywhere than nineteen thousand miles ! "

" It is indeed of enormous size," said his father. " At its outer edge it measures 176,418 miles across, and about three times as much round. Sir William Herschel, who examined this ring very carefully, with one of the finest telescopes ever constructed, found that what we call the ring is in fact two rings, one within the other, with a dark space between them, and he also observed that these rings reflect a stronger light than the body of the planet."

" Then I dare say they give Saturn as much light as many moons," said Henry. " What can he want with seven moons besides the ring ? I should think he might very well spare one or two for poor Mars, who journeys along in the dark."

Robert laughed outright at the idea of Saturn having more moons than he could tell what to do with, and so lending one or two to his brother planet; but Mary gravely repeated what her papa had said about everything being right as God made it.

"You need not look so grave, Mary," said Henry, "for I was only joking. I dare say it is all right for Saturn to have a ring and seven moons, and Mars to have none; but I cannot tell why there should be such a difference between them."

"It would be very strange if you could," said his father. "If you were a wise and learned man, instead of a little boy, you would still feel that there are a vast number of things you could not explain or understand."

"Do not you think, papa," said Mary, "that Saturn's ring must look very beautiful to the people that are, perhaps, living there?"

"No doubt it does. It must appear to them as a bright and splendid arch in their sky, and together with the moons, must indeed form a brilliant spectacle."

"Does Saturn move as swiftly as Jupiter, papa?" said Henry.

"Not quite," replied his father; "nor is he so large a planet. But his motion is very rapid; for he turns on his own axis in about ten hours and a quarter, and he moves round the sun at the rate of twenty-one thousand miles an hour. Yet so vast is the distance he has to perform, that he takes nearly thirty of our years in completing one revolution round the sun."

"Thirty years!" exclaimed Mary. "Then Saturn has been all mamma's lifetime in going once round the sun, and has only just finished his journey."

"And all these thirty years has Saturn only had one kind of season, as you explained to us about Jupiter?" asked Henry.

"Quite the reverse," said his father. "Saturn's inclination, or leaning, is much greater than that of the earth, and consequently there is a greater change of seasons, but they are very slow in coming round."

The children inquired whether it would be possible for them to see Saturn's ring, and they were told that it would not, except with a good telescope; although the planet, if above the horizon, may always be seen with the naked eye by those who know exactly where to look for him. To see all seven of the moons would require a telescope of the very highest powers.

Distance of Saturn from the Sun .	896,000,000 miles.
Diameter	79,000 miles.
Annual Revolution	10,758 days, 23 hours.
Diurnal Revolution	about 10¼ hours.
Motion in its Orbit	21,000 miles per hour.

SATURN'S RINGS.

Exterior Diameter of Outer Ring .	176,418	miles.
Interior ditto	155,272	„
Exterior Diameter of Inner Ring .	151,690	„
Interior ditto	117,339	„
Equatorial Diameter of the Body .	79,160	„
Interval between the Planet and the Interior Ring	19,090	„
Interval of the Rings	1,791	„
Thickness of the Rings not exceeding	100	„

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"Strange kind of neighbours," said Mary, "when they always keep so far off from us."

"Never mind that," said Henry; "they belong to our system, and get their light from our sun, and they all move as we do, day after day, and year after year; therefore I shall call them neighbours, and I only wish we could get better acquainted."

Their papa, hearing them regret that they were about to hear the history of the "last two planets," told them that we must not speak positively about their being the last. "The newly discovered planet Neptune," said he, "is the last of our system known to us at the present time, yet we cannot say that no future discovery will be made in the solar system. And (as I have already told you) before the discovery of this planet, people used to speak just as confidently of Uranus as the last planet, as we now do of Neptune."

"Then we may, perhaps, hear of another large planet some day," said Henry, "just as we have lately heard of some little new planets among the Asteroids."

"Certainly. In the mean time, let us inquire about the distant world which we now call Uranus."

"Was it ever called any thing else, papa?" said Robert.

"It has been known by three names," answered his father. "It was first discovered on the 13th of March, 1781, by Sir W. Herschel, who had constructed a telescope of great power, and was employing it in observations of the highest importance. Uranus could sometimes be seen as a star of the seventh magnitude with the naked eye, and had been noticed by one or two former astronomers, and set down among the fixed stars; but no one suspected it to be a planet, until Herschel, by looking at it through his telescope, found that it then appeared as a star of the first magnitude. Now, would it have appeared so much larger through a telescope, if it had been at the immense distance of the fixed stars?"

"No, papa," said Henry, "for you told us that the fixed stars are too far off to be magnified by any telescope. They do not look any larger, only a little brighter."

"And therefore," continued his father, "Herschel knew at once that it could not be a fixed star. He then supposed it might be a comet, but on watching its motion among the neighbouring stars he became convinced that it was a planet, and he therefore named it *Gecrgium Sidus,* or Georgian Star, in honour of the reigning king, George the Third. By this name it was for some time known in England, but foreign astronomers called it Herschel, from the name of its discoverer. At last the Royal Academy of Prussia gave it the name of Uranus, by which it is now usually called. As Herschel continued to observe this planet, he gradually discovered six moons revolving round it, two of which were more easily seen than the rest. The other four could only be distinguished by the highest powers of the telescope, and are most difficult objects to get a sight of, even with the best instruments. It is just possible to see the planet itself on a fine clear evening, when the moon is absent; but it is very rare to get a sight of it without a telescope."

"Is Uranus a small planet?" asked Mary.

"It is smaller than Jupiter or Saturn," said her father, "but it is about eighty times as large as our earth."

"How very far it must be from the sun!" remarked Henry.

"It is distant from the sun the enormous quantity of eighteen hundred millions of miles, and does not receive more than a four-hundredth part of the light and heat enjoyed by our earth."

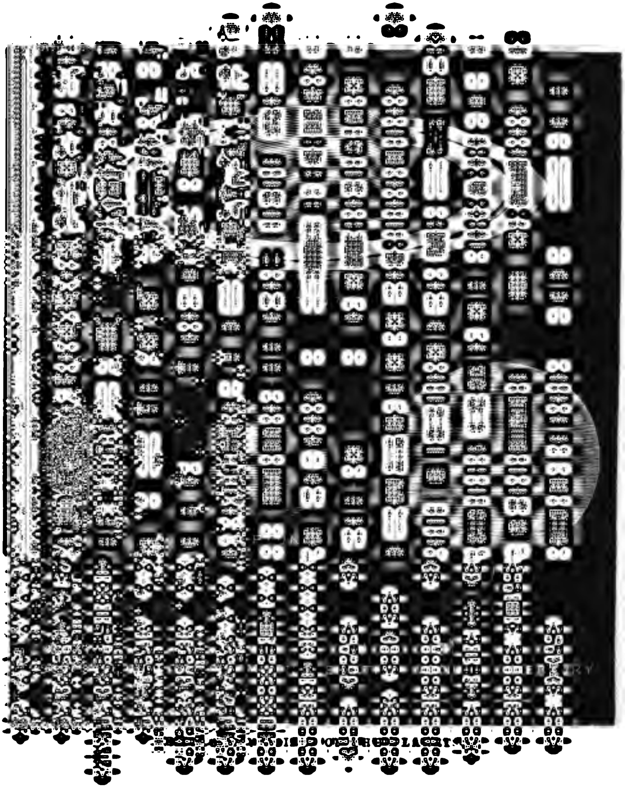
"Then is it not dreadfully cold and dark there, papa?" asked Mary.

"If it have the same kind of atmosphere as ours, it must be so cold, that our severest winter-weather continued all the year round, would be warmer than its mildest season.

'When the keen North with all its fury blows,
Congeals the floods, and forms the fleecy snows,
'Tis heat intense, to what can there be known;
Warmer *our* poles than is *its* burning zone!
Who there inhabit must have other powers,
Juices, and veins, and sense, and life, than ours.'"

"How I pity them!" said Mary. "I thought the Esquimaux were very badly off, when Henry read about them this morning; but if it is colder in Uranus than in their frozen country, the people can never know what warmth is."

"Nor do they need it," said her father. "If there be inhabitants in Uranus, they must be so completely different to us, that the warmth of our globe would destroy them. It is just as easy for the Great Ruler of the universe to adapt their bodies to a severe climate, as ours to a temperate one."



A picture of Uranus was here produced, and the children wondered the planet had not a ring like Saturn, which they thought he much wanted to light him on his dreary way. Their papa told them that the surface of Uranus appears to be equally lighted up, and without ring, belts, or spots. He likewise informed them, that Uranus is nearly eighty-four years in performing his journey round the sun. "Of the planet Neptune," he continued, "I have very little to say. He was only discovered in 1846, and although some observers believe him to have a ring, and at least two moons, it is too early to speak with certainty of a planet which can only be seen by means of a large telescope."

Having thus learned something of each of the planets, the children were pleased when their papa gave them a picture, showing the different sizes of the planets as compared with each other.

Distance of Uranus from the Sun	1,800,000,000 miles.
Diameter, about	35,000 miles.
Annual Revolution	30,686 days, 20 hours.

COMPARATIVE SURFACES OF THE PLANETS.*

Mercury	$\frac{1}{6}$th	the surface of	the Earth.
Venus	$\frac{29}{30}$ths	do.	do.
The Moon	$\frac{1}{13}$th	do.	do.
Mars	$\frac{1}{3}$d	do.	do.
Asteroids	unknown, but very small.		
Jupiter	130 times	the surface of	the Earth.
His Satellites . . .	3	do.	do.
Saturn	100	do.	do.
His Rings	140	do.	do.
His Satellites about .	4	do.	do.
Uranus	19	do.	do.
His Satellites . . .	2 or 3	do.	do.
The Sun about . . .	12,500	do.	do.

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* The reader must not confound *size* or *bulk* with *surface.* If, for example, the diameter of Saturn be 10 times that of the Earth, his surface will be 100 times the surface of the Earth, and his bulk 1000 times the bulk of the Earth.

CONVERSATION XI.

COMETS.

Henry was glad to hear his papa say, that although he had spoken of the fixed stars and the planets, there were yet other heavenly bodies to be described. "I mean," he said, "those extraordinary bodies called *comets*, which have always caused much terror among mankind, and are less understood than the rest of the starry host."

"Are not comets very terrible things," said Mary, "with fiery tails stretching far behind them?"

"There is nothing alarming about them," said her father: "and as to their tails, there is so great a variety in comets, that some very large and bright comets have had no tails, while many smaller comets have had immense tails."

"Comets come into sight for a little time, and then go away again, do they not, papa?" said Henry.

"They do; but it has now been proved, that a

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represents the sun, and the oval line is the orbit in which a comet is represented. From this being the shape of the orbit, the comet is sometimes very near the sun, and at other times at a very great distance from him."

"Is the comet a world, and is it lighted up as ours is, papa?" asked Mary.

"It is impossible to say what a comet is," replied her father. "It has been supposed that the body of the comet is composed of a dense mass of vapour, and that every time it approaches the sun a great portion of this vapour is dissipated by the extreme heat. This idea agrees with the appearance of comets, for they are often accompanied by an immense cloud of vapour called 'the tail,' and on each return of the three known comets, they have also become much smaller."

"If they grow less and less, they will vanish quite away, at last," said Henry.

"The comet which is represented in the following picture," said his father, "has changed in a surprising manner since it was first observed. It only comes once into view in about every seventy-six years; but its appearance can be traced with great probability as far back as one hundred and thirty years [illegible] is [illegible] ble [illegible] of

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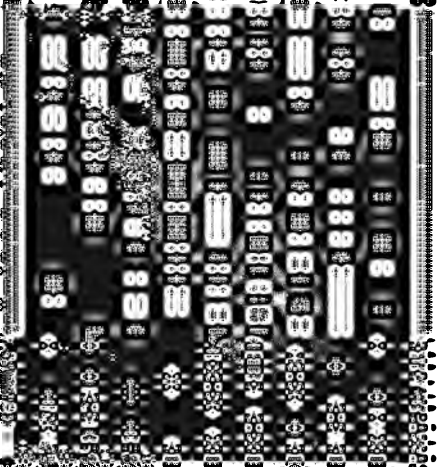

[illegible] was [illegible] England [illegible] length of that seen in 1456. In 1835, when it last appeared, it was again greatly diminished, so as to be quite an insignificant object to the naked eye. This comet is called Halley's Comet, in honour of the astronomer who thus discovered its revolution round the sun, and the period at which it would return."

"Are we ever likely to see it, papa?" asked Robert.

"It will not be seen again until 1911," replied his father, "therefore you cannot see it unless it please God to prolong your life to the age of seventy or thereabouts. The other two comets whose orbits have been pretty well ascertained, are called Biela's comet, and Encke's comet, from the names of the astronomers who calculated their return. Besides these three, there are two others whose periods have been calculated, and which are now admitted as members of our solar system. A most extraordinary comet was visible in the year 1680, and if such were to appear now, I could easily pardon your being alarmed at it, but its return is not expected to take place for several hundred years."

"What was there in that comet so very extraordinary?" inquired Henry.

"The enormous extent of its tail," said his father, "which reached from the horizon to the point immediately over head."

"What is the horizon?" asked Robert.

"The distant line where the earth and sky seem to meet. Look at that low range of hills yonder; you can see nothing beyond them but the clouds. Those hills form our horizon."

"But what would be the horizon if we were out at sea?" asked Mary.

"The waters themselves would form the horizon. Do you not remember the distinct line of the waters at Brighton? On looking out over the sea, you were in no doubt which was water and which was sky, unless a fog seemed to blend the two together."

"Oh! I remember it very well," said Henry, "and how it changed colour according to the weather; sometimes it was a long blue line of waters, sometimes it was greenish; and in cloudy and rough weather it was almost brown, except where it threw up the white surf. I often used to notice it when I was walking on the beach."

Henry was going on to describe some of the attractions at Brighton, when his papa reminded him of the comet and its wonderful tail, which seemed suddenly to have gone out of his mind.

"Well, papa, and what harm did this great comet do?" asked he.

"None whatever. Comets have never injured mankind in any way; and none but very ignorant persons expect evil to happen on account of them. If it is true that comets lose much in vapour every time they approach the sun, then the long tail of this comet of 1680 will be easily understood, for Sir Isaac Newton reckoned that the comet went so near the sun as to be exposed to a heat two thousand times greater than that of red-hot iron. Halley's comet does not approach the sun so closely. When at the nearest it is between Mercury and Venus, and when at the greatest distance it is twice as far off as Uranus."

"Then at one time a comet must be in a very hot climate, and at another in a very cold one."

"That is true," replied his father. "The whole subject of comets is wonderful, and, at present, unaccountable. And in thinking of them, and of the whole of the solar system, I would have you often raise your thoughts to the great Author of all these wonders. 'He can create, and He destroy.' It is by His power that all things are upheld, and one word of His would be sufficient to bring ruin upon all these worlds."

NAMES OF THE PRINCIPAL COMETS, AND PERIODS OF THEIR REVOLUTIONS.

Comet.	*Period of Revolution.*	*Next expected Return.*
Encke's	About 3¼ years.	1849.
De Vico's	„ 5½ „	1850.
Faye's	„ 7½ „	1851.
Biela's	„ 6¾ „	1852.
Halley's	„ 75½ „	1911.

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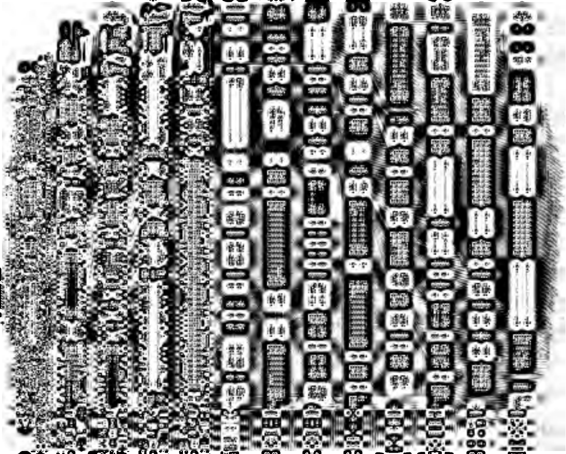

[illegible] wedge [illegible] well as [illegible] the use [illegible] such [illegible] the [illegible] think how they can be useful to us, or what benefit it can be to us to know their history, except for the pleasure of it."

"If you wish to know the uses of the heavenly host to our world," said his father, "take your Bible, and read the fourteenth verse of the first chapter of the Book of Genesis."

Henry read as follows: "And God said, Let there be lights in the firmament of the heaven, to divide the day from the night; and let them be for signs, and for seasons, and for days, and for years."

"I know, papa," said Henry, "how the seasons are caused, and why day and night come so regularly; but I want to know the use of learning all about the stars; for they would do just the same if we knew nothing about them."

"That is true," replied his father; "but you must remember, that 'the heavens declare the glory of God, and the firmanent showeth his handywork;' so that, if there were no other use in a knowledge of astronomy, it would be quite sufficient, that the more we study it, the more we shall know of the wonderful works of our Heavenly Father. But there is also a use connected with the every-day business of all our lives; for if men had never discovered the beautiful and regular motions of the heavenly bodies, they would not have been able to *measure time* as they do now. A great use of astronomy is to regulate the order of time."

"I had quite forgotten that use, papa," said Henry.

"By the sun we mark out our years, seasons, and days," continued his father; "by the moon we reckon our months and weeks. You may, perhaps, fancy that this is a very easy thing, but in the case of months and years it has been found very difficult."

"And yet it seems as if it would be easy enough to reckon from one new moon to another for a month, and from the shortest day to the shortest day for a year," said Henry.

"But it happens that neither the month nor the year is completed in an exact number of days. Although we speak of the year as consisting of 365 days, it contains nearly a quarter of a day over. For about four hundred years this quarter of a day was taken no notice of in the reckonings of time, until at last we were so much in the wrong that our year began ninety days, or about three months, too soon."

"And could any one make it right again, when it had once gone wrong?" asked Mary.

"They could, and did," replied her father, "although the attempt caused much confusion. It was in the time of Julius Cæsar that the mistake was found out and rectified. A plan was then contrived for making our reckonings more exact for the future. The quarter of a day was taken account of by making every fourth year to have one day more than the rest. This fourth year is called Leap-year, and contains 366 days. But even this contrivance did not bring it exactly right; so that, after many hundred years had passed, another change in our reckoning was wanted."

"And when was that made, papa?"

"It was made in 1582, when it was determined that every hundredth year, for three centuries in succession, should be a common year, and the fourth hundredth year should be a leap-year. Thus the years 1700, 1800, and 1900, are common years, and the year 2000 is a leap-year. This brings the reckoning so nearly right, that in twenty thousand years there will only be an error of one day.

This plan was not adopted in England until 1752. At that time we were eleven days wrong in our reckoning, and accordingly eleven days were taken out of that year, leaving only 354 days. This was so unaccountable to the lower classes at the time, that numbers of persons loudly complained that government had robbed them of eleven days."

"How silly of them!" said Henry. "They ought to have known that nobody could take away the days, any more than they could give them new ones."

"True," answered his father; "but as they did not understand the reason for it, we can scarcely wonder that they were startled at having to skip over eleven days, from the second of September to the thirteenth; for that was the time when the alteration was made."

"It must have been strange indeed, papa," said Mary, "and I think if we had to pass over eleven days now, it would seem almost as if we had lost the time; and, suppose either of our birthdays happened to come on one of the days, we should lose that too."

Henry and Robert laughed at the thought of losing their birthdays; and their papa told them that he knew a gentleman whose birthday happened on the 29th of February, and therefore it could only come once in four years, that being the day which is added to make the reckoning right. "This gentleman, when at the age of forty-four, used to puzzle young folks by telling them that he had just kept his twelfth birthday."

"If the days of the year have been thus difficult to reckon," continued their father, "the days of the month have also required some management to bring them within the limits of the year."

"How is it that the reckoning from new moon to new moon will not do?" said Henry.

"Because twelve moons, or lunar months, are not quite so long as a year."

"Then why not have thirteen?" asked Mary.

"Because they are longer than a year," replied her father. "A year contains twelve lunar months and eleven days over."

"Eleven days too much, again!" said Henry.

"Yes; and this occurring every year, if we reckoned our months by the moon's age; therefore, these eleven days are divided amongst the different months, some having thirty, others thirty-one days,—as you have learned in your lines:—

‘Thirty days hath September,
April, June, and November;
February hath twenty-eight alone;
All the rest have thirty-one;
Except in Leap-year, at which time,
February's days are twenty-nine.’”

“How can we know whether it is Leap-year or not?” asked Henry.

“Most people keep almanacks in the house, and turn to them for information respecting the divisions of time; but there is an easy rule by which you may find out whether it is Leap-year or not. Take any year—say 1846—and divide the last two figures by 4; if there is a remainder, subtract that remainder from 4, and you have the number of years which it wants to Leap-year.”*

Henry took his slate, and set down the figures thus:—

4)46 ; saying, “Fours in four--one; fours
11—2. in six—one—and two remaining.”

He then subtracted the remainder, (saying, “Two from four, and two remain;”) and found that it wanted two years to Leap-year. He also tried the three following years thus:—

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* There is an exception to this rule in the case of the year that begins the century. See page 123.

1847 4)47 11—3.	"Three from four—one remains; therefore it wants one year to Leap-year."
1848 4)48 12.	"No remainder; therefore, that is Leap-year."
1949 4)49 12—1.	"One from four—three remain; therefore it wants three years to Leap-year."

His papa then spoke of the days of the week. "From the very creation," he said, "the weeks have contained seven days; six for labour, one for rest. This is a merciful provision for the wants of man, ordained by God himself, and therefore perfect, and exactly suited to our bodily strength and circumstances, as well as to our spiritual need. It also happens that this week of seven days is very nearly one quarter of a lunar month, so that full-moon is always about a fortnight after new-moon."

"Do the weeks come right at the end of the year, papa?" asked Henry. "I mean, are there just enough to fill it, without any days over?"

"There are fifty-two weeks in a year; but there is one day over; so that every year begins one day later in the week than the year before."

"How do you mean, papa?" said Mary.

"I mean that if the first of January happens on a Monday in one year, it will fall on a Tuesday the next year, because there is the additional day to come in at the end of the old year. But if it be leap-year, there will be two days over, instead of one; so that the new year will begin two days later in the week."

"Can we see about all this in a common almanack, papa?—and will that tell us when it will be new moon or full moon, and what time the sun rises?"

"All this you will find in any good almanack; but I must mention, that the time of sun-rising is different in different places; so that if you were at Edinburgh, an almanack made only for London would be of no use to you in that respect."

"Please will you explain how that is, papa?" said Henry.

"It is caused by difference of *latitude*," said his father, "and I will endeavour to give you some notion of the meaning of that word. You remember the name of the line which separates the globe into two hemispheres?"

"Oh yes, papa; it is the equator. We very often draw such a line on oranges and apples, just as you did when you explained about the northern and the southern hemisphere."

"I also told you that there are many other lines drawn on an artificial globe to help us to measure distances correctly. All the lines drawn round the globe in the same direction as the equator are for the purpose of marking *latitude*, that is, the distance of any place north or south of the equator."

"But there are lines the other way also," said Henry. "What are they for?"

"Those lines which reach from one pole to the other are for marking *longitude*, or the distance of any place to the east or west of our own country."

"How is this done, papa?" asked Henry.

"If you know the distance from one of these lines to another, it is easy to reckon the distances of the places lying between. Now, the distance between each of those lines which mark the longitude is fifteen degrees, that being the space which the sun appears to pass over in an hour. We begin our reckoning from the line which passes through our capital city, London."

"But what is a degree?" said Mary.

"Every circle, whether large or small, is divided into 360 parts called degrees, the size of the degree varying of course with the size of the circle. At the equator, a degree contains about sixty-nine miles and a half. The lines which mark the latitude are ten degrees apart."

"All this seems very difficult," said Henry.

"It *will* seem so, until you have practised on the globes, or with good maps, the way of finding the latitude and longitude of places; when you have done so, you will find it both easy and pleasant."

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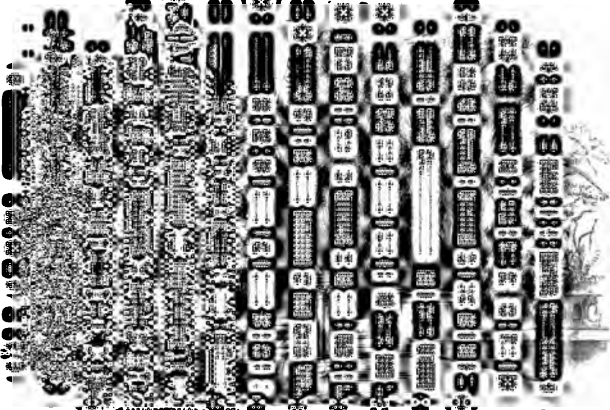

[illegible] ing [illegible] they [illegible] do, [illegible] their [illegible] and [illegible] went down towards the horizon. Mary begged her papa to look at the tall thin shadows, and see whether they were like either her brothers or herself. He told her there was not much resemblance, and that he could not have guessed they were the shadows of his little folks.

> "Giant-like their shadows grow,
> Length'ning o'er the level ground."

"By these shadows," he continued, "you might tell pretty nearly the time of the day. Any object capable of casting a shadow may be made a time-measurer."

"Then are we all time-measurers?" said Henry.

"We might be, if we chose to stand in one spot all day long, while the sun was shining; but this would be a sad waste of time, when a stick thrust into the ground would do just as well."

"Oh, do tell us how to measure time with a stick, papa," said little Robert. "I dare say that would be easy; and you know I have never been able to learn what it is o'clock by the watch yet."

"To measure time by a stick would want more patience and attention than little boys and girls are likely to have; so I think you must make up your mind, Robert, to learn the time in the regular way, by the clock and watch."

"But, if it will not be troublesome to you, papa, please to explain the way of doing it with a stick," said Mary.

"If you fix a stick or rod upright in the ground, in a sunny place, allowing it to stand exactly two feet above the surface of the earth, you may, in the course of time, get much information as to the hour of the day and the season of the year. You would do this by means of the shadow of the stick, but it requires attention, and the noting down of what you see. You will soon observe that the shadow is always shortest in the middle of the day; therefore, if you take notice of the time when it is shortest, you may know that that is noon, or twelve o'clock."

"But how could I tell when it was shortest?" asked Robert.

"That would be very easy," said Henry; "you could set a little peg in the ground, and move it as the shadow moved; and when you found it come to the shortest, you could let the peg stay there."

"Yes," said his father, "or you could measure the length of the shadow with your rule, and write down its different lengths in a book. As the shadow is shortest at noon, so it is longest at sunrise and sunset."

"That must be the reason why our shadows look so tall now," said Henry, "for it is very near sunset."

"The twelve o'clock shadow will point exactly north and south all the year round," continued his father; "which is another useful thing for little folks to take notice of. The shadow will gradually get shorter from sunrise till noon, and will gradually get longer from noon to sunset; and if you measure the shadow at different parts of the day, you will find that it is of the same length so many hours before noon as it is the same number of hours after noon."

"I will get a smooth stick and set it up in my garden, to try all this," said Henry.

"And I in mine," said Mary; "but suppose the sun should not shine?"

"You will not then get a shadow, of course," said her father. "But there are enough sunny days in the year to answer the purpose. If you put down in a book the exact length of the twelve o'clock shadow, you will find that it is much longer in winter than in summer. Indeed, if you measure it on the first day of every month, you will find it to differ in the following manner:—

	ft.	in.		ft.	in
1st of January .	7	3¾	1st of July	1	1
— February .	5	1	— August . .	1	4
— March . . .	3	4	— September .	1	10
— April . . .	2	1¾	— October . .	2	10½
— May	1	5¾	— November .	4	6
— June . . .	1	1½	— December .	6	8½

In this way you may know the seasons of the year. Now, although we have much better guides, and have no real occasion for such a contrivance as this, it is well to be acquainted with it. We can fancy that a shipwrecked person, cast upon some desert island, and having no other means of reckoning time, would be very glad to measure the hours and trace the seasons in this way. This is, in fact, a rough sort of sun-dial."

"I suppose it would not do quite so well as the sun-dial opposite our house?" said Robert.

Mary remembered that the sun-dial had not an upright rod to produce the shadow, but a slanting one. Her father explained to her that, in order to measure time with the greatest exactness, it is necessary for the *style* (which is the part that casts the shadow) to incline in the same way that the earth itself does. "Figures, marking the hours," he said, "are placed round the edges of the dial-plate, at such distances apart as the shadow travels in an hour. Sun-dials are very ancient, but are now almost out of use in this country. They are more useful in southern climates, where the heavens are unclouded and serene, and the shadows more strongly marked and distinct. Sun-dials are of two kinds; those which are upright and set against the wall, and those which are flat, and set on pedestals in lawns and other open places."

The children were then told that there were several ways of measuring time practised by our forefathers, but now, for the most part, gone out of use.

"Oh yes, papa," said Mary, "in my little book of history I have read that Alfred the Great taught people a way of measuring time by candles. I suppose he had them made to burn so many hours."

"And very likely he marked them in some way to know the hours and half-hours," said Henry.

"But he must have kept them burning all day long," said Robert, "or else he would only have known what it was o'clock after dark."

"And he must have kept them in a cool place, and where there was no draught," said Henry; "for candles burn away very fast when the wind blows upon them, or when they are near the fire; and they would not do to measure time with unless they burned always alike,—would they, papa?"

"Certainly not. Their not burning the same at one time as at another, makes them but poor time-measurers. The water-clock was another contrivance for the same purpose. This was a vessel of water, having a very small opening at the bottom, through which the water dropped slowly into a vessel beneath. This was made in a variety of ways, and was much used among the ancients. At a later time sand was used instead of water, and thus the hour-glass was formed. You have seen an hour-glass, have you not?"

"Yes, papa," said Mary, "cousin Fanny always has an hour-glass on the piano when she is practising; and as soon as all the sand has run through, she shuts up the book."

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FIRST STEPS IN GENERAL KNOWLEDGE.

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THIS SERIES WILL BE COMPLETED IN FIVE PARTS,
IN THE FOLLOWING ORDER—

Part I. THE STARRY HEAVENS.
II. THE SURFACE OF THE EARTH AND THE ATMOSPHERE.
III. THE ANIMAL KINGDOM.
IV. THE VEGETABLE KINGDOM.
V. THE MINERAL KINGDOM.

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